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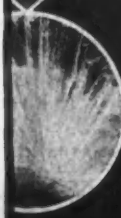

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Editorial:
What Use Chemists? ..... Inside Front Cover

25¢

What Use Chemists?

▶ IF THAT MYTHICAL man in the street were asked: "What are chemists g for?" he might reply:

"To help make atomic bombs, of course."

We have lived through one year plus during which we have realized have the atomic bomb. Chemistry, physics and a large part of the other scien have been lumped together in the popular mind as "the atom," just as thou there were no other atoms than U 235 and Pu 239. (It won't do any good protest at this convenient shorthand of the common man. Purists don't need use it in their scientific papers.)

The point is that it is very important what the public thinks and kn about science, chemistry included.

To steer an intelligent course in a stormy world, all the people must p ticipate in decisions that have a large chemical admixture these atomic da

One use for chemists is to advise and explain this necessity. To the ext that people, all the people, understand what goes into chemical indust what chemistry can do in the home, on the farm, in hospitals, on the str in international relations, they will make the correct decisions. The pe must consider the basic technicalities of chemistry just as chemical industrial must consider more than patents and profits.

It is terrifically important that people get their hands dirty in simple che cal experiments that can be performed with stuff on the dinner table and the kitchen. They must know that chemistry is not magic, that anyone be a chemist if he really wants to be.

That should be the objective of all good science teaching and all good scie dissemination. That is one reason why CHEMISTRY enters bravely into its 2 year.

CHEMISTRY

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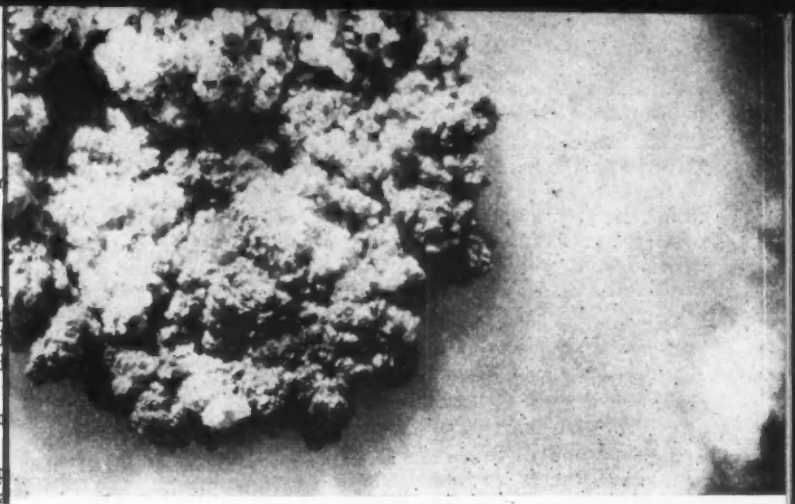

—Photograph by Joint Army-Navy Task Force One

RADIOACTIVE MIST *and billowing atomic bomb cloud of the second Bikini test is viewed from a drone airplane above in this official photograph. Note the ship in the upper right corner. Other views on back cover and pages 32-33.*

Radioactive Poison Warfare

Weary though we may be of hearing about the dangers resulting from the release of atomic energy, the editors of CHEMISTRY *believe that this straight-forward account of possible effects of atomic bomb by-products is of major importance today.*

A WORLD "hot" with death-dealing radioactive mists and dusts and pleasant lands ruined for scores of years by exploding atoms—such are fearsome consequences of the release of atomic energy if international control is not achieved.

The greatest danger to mankind from the fission of uranium and plutonium may not be the explosion of atomic bombs but the spread of the fission products of their transmutation, formed slowly in chain-reacting piles or explosively in the bomb

The fission products are a large group of radioactive isotopes of 30 or so known elements occuring near the middle of the periodic table.

That is a mild-sounding chemical way of saying it.

Out of the explosion of the atomic bomb and out of the great chemical plants that manufactured the plutonium for the bomb there come a hundred or so elements that spontaneously release explosive energy as

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radiation for hours, days, months and in some cases hundreds of years.

This artificially induced radioactivity will continue no matter where the elements are or what is done to them. For they are in a very real sense elements, immutable by any chemical combination or attempted decontamination.

They are powerful producers of radiations more deadly than all the X-ray machines in the world and all the radium produced since the Curies discovered radium.

In all of the atomic bombs exploded so far in the world, particularly the first four, the radioactive products of the bomb's explosion have been shot high into the upper atmosphere and have dissipated into the stratosphere without creating a permanent menace.

The shallow subsurface explosion of the second Bikini atomic bomb retained more of the radioactive isotopes within the water and upon the surface of the target ships, but most of the debris of the bomb rose upward in the great mushrooming cloud so familiar in atomic bomb explosion photographs.

Days passed before the ships sprayed with the radioactive mist and water could be boarded with safety. The extent to which the targets were permanently affected so that they remained "hot" from radioactivity may be one of the results of the test that will not be announced under the cloak of military secrecy.

A really deep underwater atomic bomb explosion such as scheduled for next year may cause the ocean to retain most of the atomic products within the water and thus create a death-dealing area of the ocean that would persist and migrate for months and even years.

Less spectacular than an explosion would be the use of the fission by-products in radioactive warfare. This was actually considered for use by American military forces during the war, but not used for the same reason, presumably, that germ or biological warfare was not used although we were ready both offensively and defensively. There was fear that the Germans might use it, if they got fission operating on a sufficiently large scale.

There is no particular secret about the existence of these radioactive poisons. The famous Smyth report quotes a report by Profs. E. Wigner and H. D. Smyth of Princeton, written four years before the first atomic bomb was exploded, which concluded that the fission products produced in one day's run of a 100,000 kilowatt chain-reacting pile might be sufficient to make a large area uninhabitable if it were used like "a particularly vicious form of poison gas." (CHEMISTRY, Oct. 1945, p. 18)

There are many disadvantages to radioactive poisons in active, immediate warfare. The artificially radioactive materials would be relatively slow-acting compared with TNT or the explosion of the atomic bomb itself. The enemy would be killed eventually but over a period of days might be able to fight on. For instance, radio-strontium which is one of the fission by-products goes to the

bones once it has entered the body through intestines and lungs. There it will cause bone tumors and lymphatic tissue tumors. It kills 50% of test animals in 30 days.

Another disadvantage is that invading armies usually have to occupy enemy territory. If an enemy land were poisoned by radioactivity in large doses, it would be permanently doomed and after surrender the population would be condemned to a slow and painful death.

If a malicious, sadistic and ruthless group wished to lay waste to portions of the world and to wipe out populations, radioactive warfare might be resorted to without formal declaration of war or visible overt acts. High flying airplanes might spray the dust, or suicide diplomats or agents might blow the radioactive materials into the atmosphere of large cities.

If this were suspected or feared, Geiger counters for detecting radioactivity would become as important as radar as a constant defensive warning device.

There is constant danger that a chain-reacting pile will blow up and spread over a large area its poisonous radioactivity. Such a pile might be operated for peaceful power purposes. Or even in peacetime a saboteur might blow up such piles or chemical solutions containing large amounts of radioactive fission products.

Protection against radioactive isotopes is far more difficult than combating poison gases such as were produced in large quantity but not used by Allies and Axis powers in World War II. Effective disposal could consist of dispersal so that the amount of the radioactivity is reduced to safe limits. Or radioactively "hot" materials could be buried in great pits or graves.

There are neutralizing agents for such poison gases as mustard and phosgene, but for radioactive poisons there is no practical way to change them chemically so they stop their production of radiation. The atoms keep changing spontaneously regardless of the chemical compound, or heat, pressure or location.

Photographs on pages 32 and 33 and on the back cover of this issue show other views of the Baker atomic bomb test at Bikini on July 21.

Petroleum Hunting

➤ GEOGRAPHICAL PROSPECTING at Bikini Atoll before and during the atomic bomb tests may prove valuable to petroleum hunting in the southwestern United States, says Dr. R. M. Tripp, seismologist with Joint Task Force One.

With ordinary seismic hydrophones placed on various islands of the atoll and the explosions set off at different times, the time of reflection tells the story of the strata underneath Bikini.

Dr. Tripp says much of the Southwest where oil has been found has a geology similar to that of the volcanic foundation of the Pacific atoll and he expects the new knowledge gained at Operation Crossroads to help oil prospecting there.

—Photos by U. S. Army Signal Cor

➤ THIS MESS *to be cleaned up was once a plastics factory in Aue, Germany. During the war it produced munitions, until Allied bombs fell. Rehabilitation forces report on restoration of Germany's capacity to produce necessities for her population.*

Chemicals Which Brought Ruin Now Help With Rehabilitation

Making Germany Self-Supporting

➤ AMERICA is still dropping explosives on Germany, but this year they are in bags instead of bombs.

Ammonium nitrate, an explosive often mixed in with TNT, is also the richest nitrogen fertilizer available. With Europe's starving soil the target instead of Berlin, ammonium nitrate will soon be turned out at the rate of 70,000 tons a month from 15 Army-operated ordnance plants throughout this country.

Two new processes that make this emergency fertilizer program possible were described by Kenneth D. Jacobs, chemist in charge of fertilizer work at the Plant Industry station of the U. S. Department of Agriculture.

The first step in preparing the ammonium nitrate for shipment is a "graining" process used in preparing explosives.

Mass shipping of this powdered fertilizer would be impossible without treatment developed to prevent the ammonium nitrate from caking due to moisture adsorbed from the air. This difficulty is overcome by a war-born non-caking process that "wraps" each grain of the powder in two protective coats.

The first waterproof coating is a mixture of paraffin, resin and petrolatum. The other coating is of a diatomaceous earth, a fine, siliceous material, or of kaolin.

Packed in moisture-proof bags, the fertilizer is then ready for shipment overseas. Before the non-caking process was developed, ammonium nitrate was used in solutions that were mixed with other solid fertilizer material. The new powder form is cheaper and easier for the farmer to use.

Production Doubled

➤ REGULAR ARRIVALS of coal, a good supply of hydroelectric power, and improvement in transportation are the basic factors in the U. S. zone of Germany that resulted in a 100% increase in industrial production during the first four months. Continued advances, however, are not assured.

By the end of last March, the industries of the U. S. zone were producing about 20% of their capacity, the War Department estimated. Coal mining in the zone was operating at near capacity rates. A mild winter contributed to maintaining hydro generation at a relatively high level, or at about one-half of normal capacity, while locomotive and car repairs had been brought to 65% of estimated shop capacity.

Coordination between German economic authorities and manufacturers in the zone is assisting in the economic recovery, Army officers say. Food, although not plentiful, was distributed regularly, and the bulk of the population were protected from the weather by delving into hold-over stocks of clothing.

Although coal mines in the area were operating at near capacity, there was a great shortage in this basic fuel. Lack of coal limited the output of chemicals to 25% of capacity, building materials to 20%, steel to 13%, and ceramics to 5%. These are important industries in Bavaria. Even the above rates of production were achieved only by drawing on old stocks of basic chemicals, metals, components and half assembled equipment rather than new supplies from current production.

Although an improvement over the situation at the beginning of last winter, current industrial output in the zone, the War Department states, is unbalanced and in the aggregrate is far below that necessary to maintain even a minimum standard of living. Continued advances in industrial production are not assured . . . Further factors restricting expansion are the restrictions imposed by the zonal boundaries, financial uncertainties, the near absence of foreign trade, and the depressing effects of the reparations program.

Magnesium Alloys

➤ While American engineers were quite familiar with German progress in the use of magnesium up until the start of the European war, important wartime progress was closely guarded, but is now known as a result of American investigations on the ground.

A report, released by the Office of the Publication Board of the Department of Commerce, includes valuable data on German magnesium alloys, their uses and methods of fabrication. American manufacturers will find them useful. Germany developed magnesium alloys, it is said, earlier than America because of a shortage of raw materials from which to obtain aluminum.

Among novel developments in the German industry was the use of anhydrous ferric chloride to refine the grain of magnesium alloys containing aluminum. This chemical, in powdered form, was packaged in moistureproof paper, with just enough in each package to treat one batch of metal. The powder was lowered into the metal in a cylindrical steel basket at the end of a long steel sweep. Workers were protected by steel shields. No accidents or explosions were reported, the American investigators state.

In addition to processes well-known in America, the Germans developed a water dip process for making ingots. This employed a hot, thin-wall mold. After removal from the mold, each ingot was sliced for fracture examination and scalped all over. German authorities claim this process produces better uniformity of composition, less waste and consistent quality. Its principal disadvantage is its higher cost.

Among other matters covered in the report, which was made by R. T. Wood, investigator for the Technical Industrial Intelligence branch of the Commerce Department, is a 30,000-ton forging press for magnesium forgings, said to be the largest and most powerful in the world. The press was equipped with eight supporting columns and stood 85 feet above the floor. Its last war job was forging aluminum wing spar caps, 20 to 35 feet long, for aircraft.

Miracle Weapons

➤ GERMAN SCIENTISTS were Hitler's hope. They were to produce the miracle weapons that would give the German forces superiority over the Allies in spite of their wealth, resources, ingenuity and ability to produce. Near-miracle weapons nearly came, but the coming was too long delayed.

Some of the reasons for the delay are given in a report issued by the Office of Technical Services, U. S. Department of Commerce, as a result of postwar studies made in Germany by American civilian and military scientists and technical men. It was prepared by Col. Leslie E. Simon of the Army Ordnance Department.

Lack of contact and coordination between scientific groups working for the Army, Navy, Air Force and the industries, all with separate establishments, was an important reason. Jealousy between scientists and engineers was another, according to the report.

While one part of the report gives a comprehensive picture of the organization of German scientific establishments, considerable space is given to outstanding scientific accomplishments. Some of the unique contributions of German scientists are also included.

Among the unique developments is included a long-range combination instrument, called a phototheodolite, that could take pictures giving details 15 miles away, and a relatively small tube filled with phosphorescent chemicals which could be used to detect enemy infra-red waves.

Of particular interest, however, is a nearly perfected glide bomb which could be viewed on a television screen as it was guided by radio to its target, and a nearly completed beam-climbing. missile capable of following a radar beam focussed on an enemy plane or ship.

These two, together with long-range rockets and jet-propelled implements of war, were probably the principal miracle weapons that Hitler expected his scientists to produce to save him when his Army and air force failed. They nearly did so, but their achievements came too late.

Bubbles Save Lives

➤ BUBBLE baths kept Germans dumped into the sea during the war from dying of cold. The same captured device promises to give a new lift to our own air-sea rescue devices.

The bubbles were in the foam created in the middle layer of cloth of a protective suit. A powder something like kitchen baking powder was rubbed by the Germans in to the woolly rayon. This powder foamed and kept foaming for two to three hours when wet with water. The foamy layer kept the wearer of the suit from losing too much body heat.

Herbert F. Schiefer and Richard T. Kropa of the Department of Commerce's technical industrial intelligence branch ferreted the facts out of enemy sources, The foam powder contained sodium bicarbonate, crystals of citric and benzoic acids, a gelatine emulsion and two other chemicals.

Metals, Solvents, Alcohol, Fertilizers Fuels Being Produced on Pacific Coast

Chemical Industry on West Coast

➤ THE AMERICAN INSTITUTE of Chemical Engineers met in San Francisco in August and one of the principal subjects discussed was the growth and methods of new chemical industries in the western area of the United States, especially the Pacific Coast. This report on this important meeting brings CHEMISTRY readers the principal highlights.

The American Institute of Chemical Engineers, which has its national headquarters in New York, is the largest organization of chemical engineers in the world. It was organized at Philadelphia in 1908.

"Adaptation of men and industry to peaceful needs is a matter of vital concern to America," said Stephen L. Tyler, secretary of the Institute, "An industrial capacity capable of quick conversion to war or peace has always been important to the United States, and in light of modern warfare, it is today even more vital to our well-being. The chemical industries on the West Coast are important economic factors nationally, and the work and design that has gone into the reconversion of these plants represents engineering progress to a high degree. Chemical engineers have much to learn from experiences in the western area."

Phosphate-Olivine Fertilizer

➤ A NEW TYPE of fertilizer to help increase the nation's food supply will soon be made commercially available in the Pacific Northwest. Dr. R. W. Moulton of Manganese Products, Inc., Seattle, Wash., outlined the process used in producing the new fertilizer material. The plant, believed to be the first of its kind to go into commercial operations, will use a process developed in recent years largely by engineers of the Tennessee Valley Authority.

The new fertilizer will be produced by fusing olivine, a mineral found abundantly in this country, with phosphate rock from the vast deposits of Montana. The furnaces will be heated to a high temperature (about 1,500 degrees Centigrade) by means of electricity. The two rock materials react and fuse, and the resulting molten slag will be hit by a stream of high-velocity water as it is run out of the furnace. This cools the material rapidly in the form of granules, which are then dried and sized.

Ordinary superphosphate fertilizer has an alkaline reaction, whereas the new fertilizer has an acid reaction, a property which makes it particularly suitable for certain types of agricultural soils. Its high magnesium content makes it particularly effective on soils having a deficiency of this important plant nutrient. Such a deficiency occurs in many places in western Washington and Oregon.

Smokeless Fuel Process

➤ A RADICAL PROCESS for making a new type of smokeless fuel from western soft coals is now being tested in Salt Lake City. If it works out as anticipated by engineers, smoke nusiance will be eliminated according to George W. Carter, chief engineer of Coal Logs, Inc., Salt Lake City.

The process, developed experimentally over a period of some seven years, is now ready for testing in a new semi-commercial plant in Salt Lake City capable of treating 50 tons of coal daily. The invention of K. L. Storrs, president, the process will also make available important new chemicals for a wide variety of industrial uses.

Finely-divided coal continuously is passed through a heated horizontal retort which is vibrated at a controlled intensity. At a temperature of about 500 degrees Centigrade, the coal becomes semi-plastic and can be compressed and extruded in the form of long, hard "logs" about 2 inches in diameter. Only 3 minutes are required to convert the powdered coal into smokeless logs ready to use in stoves, furnaces or open fireplaces. The chemical by-products are recovered during the heating process. By a relatively simple modification of this process, a coke can be obtained that would be especially useful in practically all metallurgical industries.

Lithium from Searles Lake

➤ SEARLES LAKE in California, which supplied the nation in World War I with critically needed potash, is now performing the same role for another vital material, lithium salts, which are processed to make lithium metal, an important alloying material. The chemically impure lithium materials are recovered and purified at the plant of the American Potash and Chemical Co., Trona, Calif.

As explained by R. W. Mumford, chemical engineer at the Searles Lake plant, the lithium salt crystals were formed thousands of years ago when glacial mountain streams dissolved salts out of the rocks, flowed into a basin, and the water was evaporated by the sun. The crystals contain voids filled with brine, and it is this brine which is processed at the Trona plant to recover the lithium salts contained therein. In order to give some conception of the concentration and separation steps involved, the speaker stated that 17,500 tons of brine are pumped through the plant each day to yield 2 tons of lithium oxide.

Before this installation, the principal commercial source of lithium was a mineral ore—spodumene. The lithium content varied from deposit to deposit and also according to the depth of bed. The advantage of using brine as the starting material is that it represents a large, readily available, chemically uniform source. Other metal salts in the brine are also recovered and processed as salable by-products.

In order to extract the lithium concentrates, the brine is concentrated and the other salts, such as sodium chloride, burkeite, and sodium carbonate monohydrate crystallize out and are removed for subsequent recovery. Flotation cells, settling tanks,

filter presses and final dryer prepare the lithium concentrate for shipment.

The equipment used in this process, with the exception of the carbon plates of the flotation cells, is constructed of ordinary materials of construction with few serious corrosion problems.

As long as the present Trona process continues to operate, Searles Lake constitutes a very large stockpile of lithium salts. The raw material is now available for a much expanded peacetime output of lithium salts.

Magnesium Continuous Process

➤ MAGNESIUM, light metal, will soon be made on the West Coast by an improved and continuous process.

A. C. Byrns of Permanente Metals Corporation, a Henry J. Kaiser subsidiary, revealed that chemical engineers are streamlining the process and plant, operated during the war at Permanente, Calif. The plant, scheduled to resume operations in the near future will be the sole producer of magnesium metal in the entire west. According to the Kaiser organization, the improved process will be able to produce magnesium metal cheaper than any other method now in use in the United States and will thus be an important factor in the expanding use of this metal in the transportation, equipment, building, and other vital industries.

During the war, the Permanente plant, built in 1941, produced some 19,000,000 pounds of magnesium for war uses, together with about 80,000,000 pounds of a devastating incendiary material known as "Goop" that was responsible for burning out many of the cities and industries of Japan.

The essential steps in the plant consist of reacting common dolomite rock, together with magnesia obtained from seawater, with coke from petroleum refineries in big furnaces through which electricity is passed. At 1900 degrees Centigrade the magnesium metal comes out of the furnaces in the form of a gaseous dust. This dust is collected and compacted into pellet form and charged into electrically-heated retorts from which, at a high temperature and under vacuum, the magnesium metal is purified, and crystallized. The high-purity crystals are melted, alloyed and poured into ingots.

As used during the war, the Permanente or carbothermic process, as it is sometimes known, made magnesium in batches, but this method will be switched to a stream-lined, continuous process that will greatly reduce production costs. Other improvements in the plant are expected to improve efficiency, increase capacity, and lower processing costs. A by-product gas from the magnesium plant will be used as fuel for the adjacent giant cement plant of Permanente Cement Co., which is the largest of its kind in the world.

Alcohol from Ethylene

➤ ETHYL ALCOHOL made from ethylene in petroleum gases has fewer impurities than beverage alcohol made by fermentation. C. M. Beamer, a chemical engineer with the Standard Oil Company, of New Jersey, Louisiana Division, said that the synthetic

alcohol was shown by ultra violet absorption, an extremely sensitive chemical test, to have negligible proportions of impurities.

Mr. Beamer predicted that demand for alcohol would exceed the supply for several years to come. "Consumption during the calendar year of 1946 will be limited by the Civilian Production Administration to 150,000,000 gallons. This quantity will exceed production and it will be necessary to make up the difference by withdrawing from the stocks on hand.

Demand far exceeds production and this condition will prevail until sufficient grain or molasses is again available or until additional synthetic plants are built. For economic reasons it seems likely that in the future all grain alcohol will be used for beverage purposes. Whiskey distillers during the war turned to the production of industrial alcohol, but now have resumed the production of liquors, the stocks of which have been largely depleted.

Within the next few years, it is expected that alcohol will be made from waste liquors of paper mills, sawdust, and by the Fischer-Tropsch synthesis of hydrocarbon gases.

Alcohol from Sulfite Liquor

➤ ALCOHOL is produced from waste liquids from a pulp mill instead of from wheat or corn in the plant of the Puget Sound Timber Co. of Bellingham, Washington. The plant, the only one of its kind in the United States, was described by E. O. Ericsson, chemical engineer.

Commercial operation began last year. Annual capacity is almost 2,000,000 gallons of high-grade industrial alcohol from waste liquors of a sulphite pulp mill. This use eliminates to a considerable extent a major and costly waste disposal problem.

Waste liquors from the pulp mill are treated with steam to remove harmful gases, then cooled, and concentrated lime is added, after which a yeast nutrient is added and the liquor fermented into alcohol in the usual commercial manner over a period of 12 to 20 hours. The plant is capable of producing 22 gallons of high-strength alcohol from the liquor produced from each ton of sulfite pulp made in the company's adjoining pulp mill.

New Non-Corrosive Solvents

➤ SAVINGS will result in petroleum refineries by using an entirely new group of non-corrosive solvents, known as sulfolanes, developed during the war by the Shell Chemical Corporation.

Sulfolanes are entirely new chemicals. They are now in commercial production and their chief use at present is to remove sulfur and to separate various petroleum components, H. G. Staaterman reported.

Compared with many other commercially employed solvents, the sulfolanes also have the advantage of chemical inertness. They do not decompose in the presence of traces of acids and alkalies, or with sulfur. They can be removed from many mixtures by a simple water wash.

Sulfolanes appear promising for other applications, such as the refin-

ing of vegetable oils, such as soybean oil, linseed oil, and tall oil.

Phthalic Anhydride from Oil

➤ ONE OF the most important chemical materials used in the manufacture of modern, high-quality paints and varnishes can now be made from petroleum sources instead of from coal, Dr. Irving Levine of California Research Corporation reported.

This important development frees phthalic anhydride from utter dependence upon coal mining and coke oven operations. The Oronite Chemical Co. plant is the first of its kind in the world to use a petroleum raw material and is the first and only producer of this basic paint raw material west of the Mississippi river.

The unique plant, which is adjacent to the huge refinery of Standard Oil of California at Richmond, Calif., uses a chemical raw material known as orthoxylene. Vapors of this substance are mixed with heated air and passed through the converters at a high temperature. The crude product formed is purified by crystallization and other means, and is then ready for use in the special paints and varnishes so necessary for modern-day refrigerators, automobiles, and ranges.

Chlorate or Perchlorate

➤ POTASSIUM PERCHLORATE was necessary in large quantities for the Navy jet and rocket programs. The first West Coast plant was constructed in Los Angeles in 1941 by the Western Electrochemical Company. This chemical was usually imported before the war.

During two years of operation, plant capacity was doubled. A second plant erected in 1944 was capable of five times the productive capacity of the original plant. Expansion to double plant production became again necessary to satisfy the rocket program. Finally installations of the Basic Magnesium Corporation, Inc. of Henderson, Nev., were converted to perchlorate manufacture on a scale six times that of the Los Angeles plant.

Potassium and sodium chlorate are now being produced at a rate one hundred times that of the original pre-war installation to satisfy a world demand for this new West Coast product, according to Joseph C. Schumacher, company chemical engineer.

The essential raw materials for the manufacture of chlorate and perchlorate chemicals are salt, water, and electrical energy. A saturated brine solution is prepared and adjusted to the proper acidity. This is then electrolyzed in a battery of cells under uniform temperature conditions and circulation. The sodium chlorate is then crystallized out of solution and separated from the liquor by means of a centrifugal filter. Some of this chemical is dried, milled, and packed for sale. The remainder is converted to perchlorate by dissolving in water the wet chlorate salt, as it comes from the filter, and then electrolyzing this solution in cells similar to those used in the previous operation.

The sodium perchlorate solution coming from the cells is converted to the potassium salt by adding KCl.

For The Home-Lab

Oil of Bitter Almonds

by Burton L. Hawk

▶ This month we shall turn our attention to the field of organic synthesis—a field in which unparalleled advancement has been made in the past and in which unlimited opportunities exist for the future. Many of Nature's most valuable and useful substances can now be duplicated in the laboratory by the chemist.

In the kernels of various fruits such as cherries, peaches, plums, apricots, etc., there is a substance which is called *amygdalin*. Now this substance is hydrolyzed by *emulsin*, an enzyme, into benzaldehyde, hydrocyanic acid and glucose—a mixture which has a fragrance of bitter almonds. All of which would be very fine if it were not for the presence of a rather objectionable personality — hydrocyanic acid—public poison No. 1. Benzaldehyde, on the other hand, has the almond flavor and is not poisonous; therefore we will favor its preparation.

Benzaldehyde belongs to the series or organic compounds known as *aldehydes*. Some examples of aldehydes are acetaldehyde, a first cousin of acetic acid, and the familiar formaldehyde, a relative of formic acid. Following this line of thought, can you determine the acid cousin of benzaldehyde?

Benzaldehyde may be prepared in many ways:

(1) By oxidation of toluene with manganese dioxide and sulfuric acid.

(2) By reducing benzoyl chloride with nascent hydrogen.

(3) By the hydrolysis of benzal chloride.

(4) By boiling benzyl chloride with aqueous lead nitrate solution.

(5) By the action of a Grignard reagent (a compound of an organic halide and magnesium, such as CH_3MgI, C_6H_5MgBr, etc.) on ethyl formate.

(6) By the destructive distillation of a mixture of calcium benzoate and calcium formate.

Assuming that the average home lab is not supplied with a variety of the less common organic chemicals, we chose the last method of preparation. Calcium benzoate and formate can easily be prepared from the respective acids.

Prepare a solution of benzoic acid by dissolving a few grams of the acid in 25 ml. of boiling water. Then add as much calcium carbonate (precipitated chalk) as will dissolve in the boiling solution. Add in small quantities. Filter the solution while still hot to remove any undissolved solid and evaporate the filtrate to dryness to obtain crystals of calcium benzoate.

Calcium formate is prepared in the same manner using a hot, dilute so-

lution of formic acid (see below) instead of the benzoic acid. Be careful not to spill formic acid on the skin. It produces painful burns.

Equal quantities of the two chemicals, thoroughly dried, are intimately mixed and placed in a dry test tube. Clamp the tube in an inclined position on a ring stand and fit it with a one-hole stopper and delivery tube extending to another test tube which is immersed in cold water. Heat the mixture evenly. Benzaldehyde will be formed and will pass over and condense in the cool receiving tube. It can be readily recognized by its bitter almond odor.

Benzaldehyde, $C_6H_5 \cdot CHO$, when pure is a colorless, refractive liquid boiling at 179°. It is not very soluble in water, but is readily miscible with alcohol and ether. It is widely used in the manufacture of dyes and perfumes. If you have the patience to collect a moderate quantity of benzaldehyde, place it in a bottle, stopper tightly, and save for future experiments.

Preparation of Formic Acid

➤ IF A SUPPLY of formic acid is not available, you can prepare it from oxalic acid and glycerin. Place 5 ml. of glycerin in a small flask and add 3 g. of oxalic acid. Fit the flask with a 2-hole stopper, carrying a delivery tube extending to a receiving flask which is externally cooled. Insert a thermometer through the other hole in the stopper, allowing it to immerse in the glycerin. Heat the mixture *slowly* to 110°, when formic acid will pass over and condense in the cool receiving flask. Then allow the mixture to cool; add more oxalic acid and heat again to 110°. Repeat this procedure until you have obtained a sufficient quantity of formic acid. The acid obtained is entirely satisfactory for preparing calcium formate as described above.

Remember, one trait the home chemist must possess is that of versatility. If you lack certain chemicals needed to perform an experiment, don't fret—learn to manufacture the desired chemicals from those which are available. It can be done!

Anti-Germ Activity in Buttercup Juice

➤ THE POSSIBILITY of a remedy like penicillin being developed from buttercup juice appears in a report by Dr. Beatrice Carrier Seegal and Dr. Margaret Holden, of Columbia University College of Physicians and Surgeons.

Growth of streptococci, staphylococci, pneumonia, anthrax and tuberculosis germs and a number of other micro-organisms that cause sickness in humans was stopped by juice pressed from buttercup leaves, stems and blossoms. A steam distillate of this pressed juice was also effective in stopping the growth of the organisms. Anemone juice gave similar results.

The use of the buttercup juice as a remedy in infections was prevented by its toxicity for laboratory animals. The distilled juice is less poisonous than the whole juice.

Depths of Ocean New Frontier for Surveys of Unexplored Resources

Exploiting The Sea

➤ THE VAST REACHES of water under the surface of the sea are a highway to war or a frontier beyond which scientific conquistadores may enrich the lives of all men.

This is indicated by Comdr. Roger P. Revelle, in charge of the oceanographic section for Joint Task Force One, and in peacetime a staff member of the Scripps Institution of Oceanography at La Jolla, Calif.

While Comdr. Revelle stressed the peacetime aspects of oceanography, he indicated that the sea, which covers about 70% of the earth's surface, cannot be overlooked by nations if means for survival in atomic warfare are being sought. Speaking of this negative side of oceanography, he pointed out that atomic-powered submarines with very long ranges may not be too far in the future. He added, too, that it may be possible to track such submarines by means of their exhaust, which might emit fission products.

Fission products can be tracked in the water. Several members of Comdr. Revelle's staff are making a tracer study of the currents and the movement of radioactive fission products, using vessels equipped with Geiger counters and devices for taking samples of deep water.

The science of oceanography is only about 65 years old and there are only about a dozen important oceanographic institutions in the world. In some respects more is known about the topography of the moon than about the bottom of the sea and of distant stars than of ocean currents.

While the surface of the sea has been man's most important highway for centuries, its great depths and the storms that rage within it and create weather are only beginning to unfold.

During the war a great deal was learned about the extent to which the environment—temperatures, weather, plant and sea life—changes at different levels and in different areas of the sea.

One of the methods of study during the war was with new sound devices, such as sonar. In water as in air, the velocity of sound increases with increasing temperature, pressure and salinity.

Using their sound equipment, scientists at the Naval Electronics Sound Laboratory at San Diego found that there is a great temperature change a few hundred feet below the surface. Here there are great waves, somewhat like those on the surface, but much longer and slower moving. The lengths of these waves are up to a few hundred yards, and because of the great distance between their crests, they appear to be flat. Actually these crests are as high as 300 feet. This re-

futes all ideas that the ocean consists of somewhat stationary layers of water in the sea, with waves at the surface.

The importance of exploring the sea thoroughly is indicated by many practical considerations. It is filled with minerals of every imaginable sort. Salt, already mined from the ocean in important quantities, is present in an abundance sufficient to cover all the continental United States to a depth of nearly a mile. Bromine, essential to making high octane motor fuels, is economically already being extracted from the sea. Each cubic mile of the ocean has a quarter of a million tons of this element.

Weather forecasting, vital in so many of man's activities, is dependent to a great extent on knowledge of the sea. The movement of water vertically and horizontally, and differences in temperatures influence the humidity of the atmosphere, creating pressure areas, rain, great air movements.

In many ways the sea is more spectacular than the land. The greatest depression, Mindanao Deep, off the coast of the southern Philippines, is 35,400 feet deep, while the highest mountain on land, Mt. Everest, is 29,000 feet. If irregularities of the earth's crust were smoothed into a rounded ball the earth would be covered by 7,500 feet of water.

Bubbles at Work

➤ INDUSTRY for years has been using bubble-baths on a very large scale. Thousands of machines are operating in mining communities throughout the world to produce useful bubbles for separating valuable mineral constituents from worthless gangue by the froth-flotation process.

The industrial bubble is a most complex structure consisting of an infinitesimally thin film surrounding a core of air. The film itself is composed of an interior membrane of water with a concentration of a very slightly soluble oil on the outer and inner surfaces. The oily compound chosen must possess a polar molecule with one end water repellent and the other end water avid. It orients itself in the surface film of the bubble with the water repellent end away from the water membrane.

The ore dressing engineer chooses frothing compounds yielding the most effective size of bubble, producing the necessary toughness of film, and insuring satisfactory persistence without carrying this latter to extreme. Since he must break these bubbles again within the time and equipment capacities of his apparatus, he uses chemical reagents which are specifically designed to form froth of suitable character for each of the many applications.

The mineral constituents of an ore present problems of surface character which require the use of additional materials known as promoters. These are complex chemicals which are specific in their action and intensify the ability of one class of minerals, or even a single one, to attach itself to an oil froth film, while having little or no

effect upon the others in the ore mixture. Thus by the use of frothing agents and promoters in apparatus designed for beating up the froth and bringing the finely ground ore into intimate contact therewith, it becomes possible to sort out and float off valuable mineral constituents.

For example the sulfides of copper, lead, zinc and iron may be floated readily from silicious gangue and, by choice of successive promoters and depressants, the several sulfides may be separated one from the other. Limestone, iron ore, phosphate rock, fluorspar, and barite are other examples of ores which can be improved by separation from silicious impurities.

The operations are continuous and almost entirely automatic. The crude ore is crushed and ground to a size at which one constituent is adequately freed from another. A stream of water carries the ore to the flotation machine, the several reagents are added to the circuit, and the loaded froth is skimmed off. The operation may be repeated one or more times under different conditions for successive separations.

The physical principles underlying froth flotation were established for a single class of ore nearly fifty years ago, and the process was commercialized. In the past twenty-five years intensive scientific study has been made of this interesting phenomenon and has resulted in a wide application of the art to other and varied classes of minerals. The line of chemicals called for by the many present-day applications of the principle has become an impressive catalogue.

Froth flotation is now applied also to the solution of many common industrial problems. Water soluble or emulsifiable cutting oils and coolants used in metal-working are clarified and the cleansed liquids are returned continuously to the system. The process is also solving problems of waste disposal.

—From *"For Instance,"*
(American Cyanimide Co.)

"Plastic Plug" For Oil Wells

➤ Oil wells suffering from the intrusion of natural gas can be returned to normal production with a "plastic plug" that seals the wells, it was reported recently.

Sixty-six marginal or non-productive wells in west Texas have been tested with the "plug" and most of the doomed wells are now yielding about $1,000 worth of oil each month, the Monsanto Chemical Company and Oilwell Chemical Service Company, Forth Worth, Texas, announced.

Used for sealing the wells from the unwelcomed gas, a resinox phenolic resin has been successfully employed in wells as deep as 11,500 feet. The resin goes into the well as liquid and hardens after it permeates the porous rock through which the gas had been coming, it was explained.

State laws setting the amount of natural gas that can be taken from a well with each barrel of oil make the problem of keeping the gas quantity under control an important economic consideration in operating oil wells.

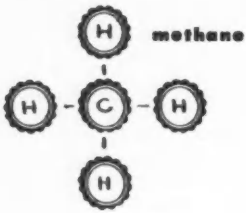
Paraffin Hydrocarbons
Aliphatic Series

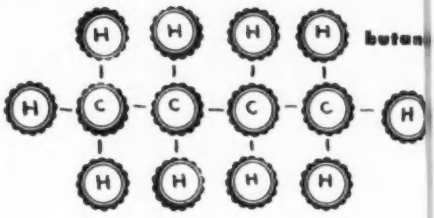
Outline of Organic Chemistry

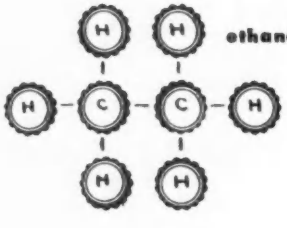
▶ ORGANIC CHEMISTRY is concerned with the manifold ways in which carbon atoms can combine with other carbon atoms and with atoms of other light elements.

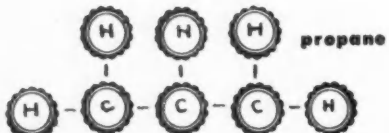
Carbon's ability to combine with itself is unique. It gives rise to a bewildering variety of substances. The chemist's ingenuity is taxed to find names for them, and to classify them in such a way that groups of compounds similar in behavior can be described together.

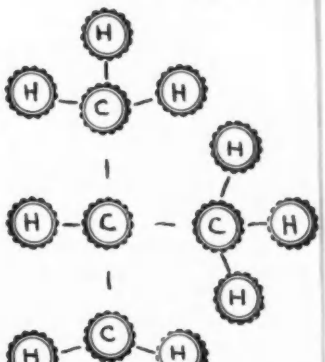
Beginning with this issue, CHEM-

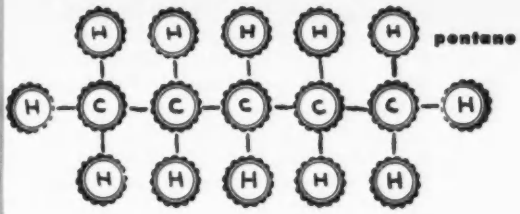




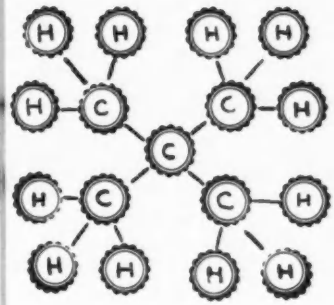




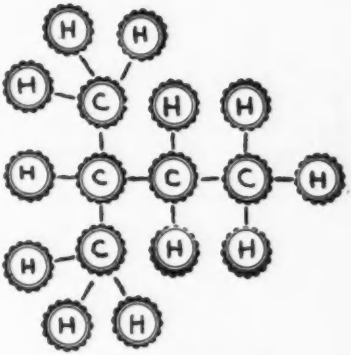




pentane



tetramethyl methane



dimethyl ethyl methane

istry will present a review course in types of organic compounds, in diagrammatic form. Starting with the simplest hydrocarbons, the typical organic compounds will be listed, then the ranks and orders of substances which lead up to the constitution of plastics, synthetic rubber, carbohydrates, vitamins and many other chemicals of vital importance.

The schematic diagrams used here are based purely on convenience. Small labels bearing the chemical symbols of the elements are easy to push around into positions illustrative of chemical groupings.

The hydrocarbon series, whose simplest members are represented here, consists of carbon and hydrogen only. The valence, or combining power, of carbon is 4, of hydrogen 1.

Valence, which is due to stresses between the electrons in the outer orbits of atoms, is conventionally represented by short lines, called bonds, joining the symbols of the elements. The novice, remembering that he is using chemical shorthand, may think of these bonds as hands. Carbon has four hands and therefore may grasp with each an atom of hydrogen, which is equipped with only one.

The simplest hydrocarbon is methane — one carbon atom combined with four hydrogen atoms. It is a gas formed when carbonaceous material decomposes without access to air. Heated in air, it burns: $CH_4+2O_2 \rightarrow CO_2+2H_2O$. Hence miners know methane as "fire damp." Taking fire spontaneously as it rises from swamps, methane is called "marsh gas," and the flashes of fire it produces are the foundation of tales of "Will o' the wisp." Methane is one of the gases which form commercial "illuminating gas."

Chemically, methane is often thought of as the theoretical foundation of all carbon compounds. By exchanging one or more of its hydrogen atoms for some other element or group of elements, new compounds can be formed. The reacting group CH_3 (which has one free valence to attach it to some other chemical entity) is called methyl. The syllable *methyl* appearing in the name of a chemical compound means the group CH_3.

If one hydrogen atom of methane is replaced by a second carbon atom with three attendant hydrogens, the second member of this hydrocarbon series, ethane is formed. It may be thought of as a combination of two methyl groups, and is in fact sometimes spoken of as dimethyl, or methyl methane. Removing one hydrogen, the reacting radical which is left is called ethyl. The complete hydrocarbon is occasionally called ethyl hydride. Thus the chemist changes the name of a compound according to his point of view.

Aside from different ways of looking at the same compound, there are different names for compounds with the same number of carbon and hydrogen atoms because the way in which they are hooked up is different, resulting in actual solids, liquids or gases with different properties such as melting and boiling points and appearance, texture and smell.

These differences result from the fact that a carbon atom attached to one hydrogen atom and three carbon atoms, for example, behaves differently from a carbon atom attached to three H atoms and one C atom.

Compounds with the same empirical formula but different structural formulas are called "isomers". They begin with butane in the hydrocarbon series, and the difference in arrangement is shown in the accompanying diagram.

Butane's empirical formula is C_4H_{10}, and in butane these atoms are lined up in a straight chain. But the same atoms may be rearranged into three methyl groups each of which replaces one of the H atoms in a methane molecule. Hence the name of butane's one isomer is tri-methyl methane.

Pentane, the next member of the hydrocarbon series, has two isomers, also shown in the diagram, whose names and structures illustrate some of the typical ways that organic compounds get their names. Add the fact that in printing strings of syllables are usually run together in the German manner, and the length of many chemical terms is explained.

If the reader who comes across long

chemical names will break them up into their chemical entities, he will find they are not such jawbreakers as they look.

Formulas are usually printed in such a way as to give an idea of chemical structure. The eight compounds diagrammed here would be printed as follows: methane: CH_4; ethane: C_2H_6; propane: C_3H_8; butane: C_4H_{10}; trimethyl methane: $CH(CH_3)_3$; pentane: C_5H_{12}; tetramethyl methane: $C(CH_3)_4$; dimethyl ethyl methane:$CH(CH_3)_2 \cdot C_2H_5$.

It is obvious that, as the number of carbon atoms increases, the number of possible isomers goes up rapidly.

As more carbon atoms are added to the hydrocarbon series each addition replaces one hydrogen with CH_3, giving a net gain of CH_2. It is thus possible to write a general formula for compounds of this type:

$$C_nH_{2n+2}.$$

The lower members, representing the better-known substances, have individual names. Those with higher numbers of carbon atoms take their names from Greek number prefixes, beginning with pentane =5. Number 8 in that series is octane, familiar as the standard for gasoline knock rating.

As is the case generally, increase in molecular weight of the hydrocarbons causes a change in properties of the resulting compound. Lightest members of the series are gases, heavier ones are liquids, still heavier ones solids at ordinary temperatures.

The solid hydrocarbons are paraffins, which get their name from their chemical constitution. Par-affin comes from "equal affinity", an old expression meaning that all the valences of the carbon are satisfied to an equal degree.

There are other series of carbon compounds in which all valences are not equally saturated. These will be illustrated in later diagrams in CHEMISTRY.

How an aldehyde differs from an alcohol, and an ether from a ketone, will be shown in the next diagrams of this outline.

Some Plastics Resist Fungi

➤ FUNGI GROW on some plastics and not on others because of the organic material in the plastics. Wartime research by the Bakelite Corporation and Boyce Thompson Institute, under contract with the Office of Scientific Research and Development, showed that the inorganic components resist such growth.

The lubricants of animal or vegetable origin support fungus growth. Fungi do not grow on synthetic phthalate, vinyl resin, phosphate plasticizers, and inorganic components. Twenty of the 32 test cultures included tropical fungi. Of the fungus preventives tested, a top-quality, moisture-proof varnish was found to protect phenolformaldehyde cotton-base laminates as well as any of the fungicidal finishes.

Size, Shape and Structure of Molecules Can Be Measured

Modern Structural Chemistry

by LINUS PAULING

The Williard Gibbs Medal of the Chicago Section of the American Chemical Society, one of the highest honors in chemical science, was awarded to Prof. Linus Pauling of the California Institute of Technology. Formal presentation was made by Prof. W. Albert Noyes, Jr., of the University of Rochester, president-elect of the American Chemical Society.

This is the second time that the American Chemical Society has conferred high honors on Prof. Pauling. In 1931, when he was 30 years old, he was given the Society's $1,000 Award in Pure Science. This prize was founded for the recognition and encouragement of younger research workers.

Prof. Pauling's research has had significance not only in chemistry, but also in physics and biology.

➤ IT IS WITH a deep and sincere feeling of appreciation that I receive this great recognition of my work, the Willard Gibbs Medal of the Chicago Section of the American Chemical Society. The investigations which I have carried on, with the aid of many able collaborators, during the past twenty-four years have covered a broad field of science, including parts of physics, mineralogy, chemistry, and biology; but, though varied in nature, they have had a common feature—an emphasis on structure; and they may all be considered as being comprised in the general subject of modern structural chemistry.

Structural chemistry—the determination of the structure of chemical substances and the explanation of their properties in terms of structure—is an old science, as old as chemistry itself. We remember Lucretius, who two thousand years ago wrote about "honey, with smooth, round molecules which roll easily over the tongue, whereas wormwood and biting centaury consist of molecules which are hooked and sharp"; and Lomonossov, whose explanations of the properties of solids, liquids, and gases in terms of moving molecules were boldly imaginative two hundred years ago, and yet were, we now know, very close to the truth. Dalton first pointed out that the weight relations of chemical reactions have a simple interpretation in terms of the combination of atoms. Avogadro and Cannizzaro showed that even in an element two or more atoms may be bonded together to form a stable molecule. Frankland, Couper, and Kekulé developed the concept of valence—the representation of combining power of an atom by a small integer. Again Kekulé made his strikingly simplifying picture of the benzene molecule as a ring of six carbon atoms, each with its attached hydrogen atom. Van't Hoff and le Bel, gave their explanation of the

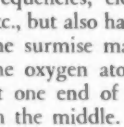
right and left handedness of some substances, first discovered by Pasteur in tartaric acid, as resulting from the tetrahedral arrangement of the four valence bonds of a carbon atom. Werner showed that the spatial arrangement of bonds determine the properties of many substances other than the compounds of carbon. He said that an atom such as platinum may, in its quadrivalent state, hold six atoms or groups about it at the corners of an octahedron, or, in its bivalent state, hold four atoms or groups at the corners of a square, rather than a tetrahedron. We remember, as the last of the great structural chemists of the past, Gilbert Newton Lewis, whose identification, in 1916, of the chemical bond between two atoms with a pair of electrons held jointly by the two atoms, vulcanizing them together, initiated the period of theoretical clarification and precise experimental investigation which has in a few decades changed the old, qualitative structural chemistry into modern structural chemistry.

Modern structural chemistry differs from the older science in being precise—quantitative, instead of qualitative, lucid, instead of vague. It is no longer enough to say that the chloroform molecule is tetrahedral in structure—we now say that the four bonds are directed almost, but not quite, toward the corners of a regular tetrahedron. Three of the bond angles (Cl-C-Cl) have the value 111°, slightly larger than the regular tetrahedral angle 109°28′, and the other three (Cl = C = H) 108°, and that each of the three chlorine atoms is 1.76 A. from the carbon atom, and the hydrogen atom is 1.09 A. from the carbon atom. The molecule may oscillate with certain frequencies, and the stretching of one carbon-chlorine bond has a certain effect on the other bonds. We use this information in discussing not only the simple physical and chemical properties of the substance but also for the calculation of its entropy and free energy and hence of the equilibrium constants for its reactions.

We have seen, during our lives, the development of modern structural chemistry. I became deeply interested in molecular structure and the nature of the chemical bond in 1919, when I first read Lewis' 1916 paper and Irving Langmuir's papers on this subject. I began experimental work in the field in 1922. At that time, only a quarter of a century ago, there was not known the distance between the atoms in the molecules of any gaseous substance, nor, indeed, of any organic substance whatever (except diamond). It was not known that the two atoms in the hydrogen molecule are 0.74 A. apart, the two in the nitrogen molecule are 1.094 A. apart, in the chlorine molecule 1.98 A. apart. These values were determined, by the methods of band spectroscopy, during the next few years. In 1922 the only precise interatomic matrical information at hand was that which had been obtained since 1913 by the x-ray investigation of crystals, all inorganic except diamond. It was known that the carbon-carbon distance in diamond is 1.54 A., but it was not known that this value holds also for the carbon-carbon single bond in other substances. The first organic molecule

for which a structure determination was made was hexamethylene tetramine, crystals of which were studied by Dickinson and Raymond in 1923. But it was not until 1929, when the technique of electron diffraction by gas molecules was developed by Mark and Wierl, that it became possible to determine the interatomic distance in a large number of organic molecules.

The methods of modern structural chemistry are largely physical in nature. They include molecular spectroscopy, the determination of the configuration of gas molecules by the diffraction of electrons, the measurement of the electric dipole moments of molecules, the measurement of magnetic moments and of diamagnetic susceptibilities, the interpretation of heat capacity, entropy, and other thermodynamic quantities, and the application of theory, especially quantum mechanics. Each of these methods in addition to providing the specific detailed information characteristic of it, has led to significant additions to our body of general chemical knowledge. Molecular spectroscopy not only has given us a great mass of data about moments of inertia, oscillational frequencies, electronic energy levels, etc., but also has verified, for example, the surmise made by Langmuir that the oxygen atom of nitrous oxide is at one end of the molecule and not in the middle.

The x-ray method proved in 1925 that the azide ion has the linear structure $N=N=N$ and not the cyclic structure  . A few years later a linear structure was verified also for the azide group in a convalent azide (methyl azide) by the electron diffraction method. It was the x-ray study of ergosterol and calciferol by Bernal which led to the assignment of the correct chemical structures to the sex hormones and vitamin D by Rosenheim and King and Wieland and Dane. Recently we have seen the great power of this method exemplified in a striking manner by its use by Dorothy Crowfoot and Barbara Rogers-Low in the discovery of the 8-lactam configuration for penicillin, for which the methods of the organic chemist had indicated an azlactone structure. I believe that, with the increasing power of x-ray diffraction methods, this technique will become a more and more useful adjunct to chemical methods for the elucidation of the structure of natural products.

Another use of x-rays is in the assignment of chemical formulas to substances so complex that the method of chemical analysis fails to yield an unambiguous answer; for example, in this way the formula $Al_{13}Si_8O_{20}(OH,F)_{18}OI$ was determined for the mineral zunyite, and $(NH_4)_6Mo_7O_{24}\cdot 4H_2O$ for ammonium paramolybdate. It has been reported that with only micrograms of the materials available Zachariason was able to establish the composition of many compounds of plutonium by the x-ray diffraction method.

The study of the patterns obtained by the diffraction of electrons by gas molecules has led not only to the determination of interatomic distances in many molecules of known chemical structure but also in a number of

cases to the discovery of the correct structure or the verification of a structure about which there was some doubt. Donohue, Humphrey, and Schomaker were able in this way to prove the spiro-pentane structure for the hydrocarbon C_5H_8 obtained by Murray and Stevenson by the debromination of pentaerythrityl bromide with zinc dust. The ortho-biphenylene structure suggested for Lothrop's hydrocarbon $C_{12}H_{10}$ by its method of synthesis was verified by its electron diffration pattern and also by an x-ray crystal structure of pirylene, C_6H_6, was finally dispelled by the electron diffraction investigation which showed it to be 1-methyl-2-vinyl-acetylene. Ethylene ozonide has been shown to have the oxide-peroxide ring structure. A number of similar studies of inorganic compounds have also been made.

From time to time new physical techniques are found to be so useful to the organic chemist that they are incorporated by him into his collection of standard procedures, and become a part of organic chemistry. This has occurred in recent years with absorption spectroscopy. The value of the absorption spectra of complex organic substances in the ultraviolet and visible regions for the purposes of characterization and of the identification of certain structural features, especially of conjugated systems. has been strikingly demonstrated during the past twenty years by the work on vitamin D and other sterols and on vitamin A and the carotenoids. A very interesting new application of spectroscopic methods has been made recently by Zechmeister and his collaborators, in the study of the cis-trans isomerism of carotenoids. It has been shown that the intensity of the principal absorption band is greater for the all-trans isomer of a carotenoid than for the cis isomers, and this property has been used for the reliable identification of the all-trans isomer as the main naturally-occurring form of many carotenoids. The structure of the isomers with the cis configuration around one or more of the double bonds has been correlated with the intensity of a new band, not shown by the all-trans isomer, which occurs in the near ultraviolet; by the consideration of details of the spectra, especially this "cis-peak." Zechmeister has made tentative assignments of configurations to many of the carotenoid isomers. An especially interesting isomer is prolycopene, which occurs in the "tangerine" tomato, giving it its bright orange color; this isomer is thought to have the cis configuration about six of its double bonds. A single gene in the tomato plant determines whether prolycopene will be formed in the fruit, or all-trans lycopene, which gives red color to ordinary tomatoes.

The field of application of modern structural chemistry which seems to me to have the greatest promise for the future is that of the explanation of the physiological activity of chemical substances. Little success has resulted from the efforts of chemists and physiologists to correlate the physiological properties of substances and their ordinary chemical properties—the properties which depend upon breaking the chemical bonds within molecules and forming new chemical bonds. I believe that usually the specific physiological properties of sub-

stances are determined not by these strong intramolecular forces, but instead by the weak forces—van der Waals forces, hydrogen bonds—which operate between molecules. The understanding of physiological activity will be consequent to the detailed consideration of those forces in relation to the size, shape, and structure of the interacting molecules. Strong evidence for this point of view has already been obtained through the study of the behavior of systems of antibodies, antigens, and haptens. I am confident that, as our knowledge of the structure not only of simple molecules but also of proteins and other complex constituents of organisms increases, we shall in time achieve an insight into physiological phenomena which will serve as an effective guide in biological and medical research. This will contrbute to the solution of such great practical problems as those presented by cancer and cardiovascular disease.

Thirty Isotopes

➤ THIRTY self-destroying chemical elements produced by the atomic bomb were made known when two Canadian scientists working at the Chalk River Laboratory of the Canadian National Research Council sent a report to the British journal *Nature* on the fission products of uranium 235.

Heretofore it has been stated authoritatively that radioactive forms of about 30 elements were produced when the bomb exploded or the chain reaction occurred. Only radioactive isotopes of five elements had been actually named: Barium, iodine, yttrium, and two rare gases, xenon and krypton.

Drs. W. E. Grummitt and G. Wilkinson in their report list 30 radioactive isotopes, giving their half-lives and their energy levels.

Six of these isotopes are previously undiscovered anywhere. Three of tin, two of antimony and one of cesium.

Two of the elements in the debris of the atomic energy reaction are very long-lived. Cesium 135 has a radioactive half-life of about 100 years, while strontium 90 has a half-life of about 70 years.

Two others have half-lives of 290 days each, cerium 144 and ruthenium 106.

Jute As Wool Substitute

➤ SCIENTISTS in India, who have been searching for chemical processes of producing rayon, paper, and cheap woolen fabrics from jute, have developed a new material from jute fiber similar to coarse wool.

Prof. S. C. Sirkar and N. N. Saha, of the University of Calcutta, announce that the new material, a hydrated cellulose, is superior to any previously developed.

During the war India's outlets for marketing its annual five billion pound jute crop, 98% of the world's supply, were so reduced that the India Central Jute Committee financed research to give jute new jobs to do at home.

Chem Quiz

Chemical Guessing Game

➤ A CHEMICAL variant of an old puzzle form uses the name or symbol of an element or a radical instead of a letter or syllable of a word. We explain one jingle and let you play with the others. The chemicals we had in mind will be found on page 42.

My first's a symbol which negates "yes",
My second's vapor's a freshman's dress;
The two together add to the taste,
And keep your food from going to waste.

The symbol for sodium could be pronounced "nay", chlorine's vapor is (at least a little bit) green, the freshman's color. NaCl is a food preservative!

1. My first is in lime, but not in a drink;
My second's in soda—still not what you think;
My whole in strata of rock is found,
And makes beautiful caverns under the ground.

2. My first is the lightest, and easily wed,
My second's a radical, not at all red;
Combined, they make a gas of death—
If near it, you must hold your breath.

3. My first's the name of a bonny lass,
My whole is poured in a brimming glass;
My second loudly you might shout
If you saw a guy pass out.

4. My first's in a pigment of yellow hue,
That we can't use now as we used to do;
My second makes sand fly away as gas,
And etches pictures in things of glass;
My whole is the answer to the hopes
Of the separators of isotopes.

Better Drycleaning Through Analysis of New Fabrics

New Fabrics Cleaners' Headaches

by MARTHA G. MORROW

Be smart in the rain . . . Bring flower-freshness into your home . . . Shadow sheer . . . Crisp as crystal snow . . . Voted "best all-around fabric." . . . Advertisements such as these mean potential trouble to the cleaner around the corner.

Drycleaning processes must be adapted to fit each new fabric. Adequate precaution against shrinkage or stretching must be taken when necessary. Ways of restoring the garment's original finish have to be devised. Some materials, all too frequently the expensive ones, can not be cleaned satisfactorily and so must be recognized before it is too late.

Several laboratories throughout the country keep cleaners and dyers up to date on special problems with postwar materials. Eternally on the outlook for new fabrics, they test each for shrinkage or stretch, strength and colorfastness. Some of the tips these experts give drycleaners would be well to remember in shopping.

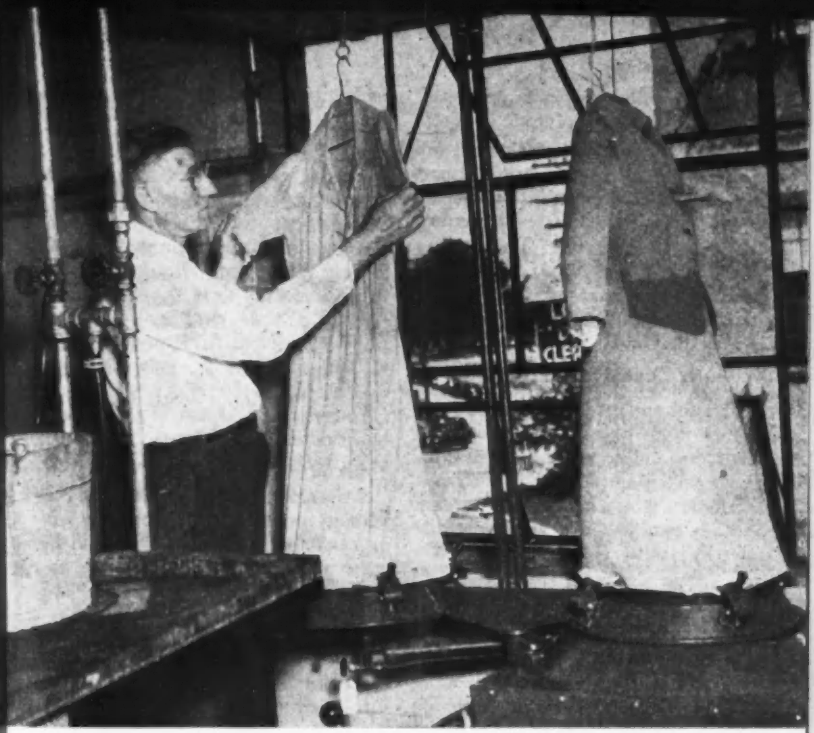
Curtains and draperies of fiberglas, printed with bright colors, are difficult to clean. The threads tend to slip, holes may be worn into the cloth with little rubbing, and the colors lose their brilliance. Surah, made of regenerated cellulose rayon in a fancy twill weave, shrinks and much of the dye and sizing are lost if moisture is necessary to remove any water-soluble spots, stains or general soil. Silk linen, on the other hand, requires little special handling as long as it is recognized as pure silk.

Adhesives Cause Trouble

Belts made by gluing material to a leather-like backing and those with buckles of fabric glued to metal are hard to clean satisfactorily. Fabrics cemented together to form a double-textured garment also cause difficulty. Many of these adhesives dissolve in dry-cleaning solvent, causing the garment to fray at the edges or come apart altogether.

To take the guess-work out of cleaning new textiles, members of the Ohio State Association of Dyers and Cleaners have just contributed more than $20,000 to establish a research fellowship and drycleaning laboratory at Ohio State University. Such research is also offered at Pennsylvania State College where the laundry research laboratory works in co-operation with the Pennsylvania State Association of Dyers and Cleaners.

The National Association of Dyers and Cleaners at Silver Spring, Md., sends frequent bulletins to its 4,000 members through the country to keep them up-to-date with current cleaning problems. Samples of new fabrics are attached to help in recognizing them. Frequently samples of the material before and after cleaning are sent to show particular difficulties to be met in drycleaning. Some far-sighted textile manufacturers have their new



➤ AFTER THOROUGH *inspection, garments which have been dry-cleaned are dried by inflating them with warm air over specially designed blowers. Photographs for this article were taken at the National Association Institute of Dyeing and Cleaning, Silver Spring, Md., by Fremont Davis, Science Service Staff photographer.*

fabrics tested at the institute to be sure they can be drycleaned satisfactorily before putting them on the market.

School for Drycleaners

A unique school run by the association will result in brighter and fresher clothes being returned from the drycleaners. Here men already in the business learn new techniques during a 12-week course. Just reopened, nearly all now attending are war veterans.

The first drycleaning plant in the world was opened about the middle of the nineteenth century by a Frenchman who is said to have used benzine, a coal tar product. For his service he used the French term "nettoyage a sec," meaning cleaning without moisture. Today wherever dry sol-

vents are employed, the process is spoken of as drycleaning.

In the beginning it was considered necessary to rip a dress or suit apart and clean it section by section, sewing it back together again before returning it to the customer. The services offered today are not so complicated and drycleaning has grown into an industry worth almost a billion dollars in the United States alone.

Solvent Dissolves Grease

The solvent used in drycleaning clothes is colorless and looks like water, but unlike water keeps shrinkage, wrinkles and loss of dyestuff to a minimum. It quickly dissolves greasy and oily materials that would not dissolve in water.

Two general types of drycleaning solvents are in use today. One is made from petroleum and is known as Stoddard solvent. About 80% of the drycleaning in the country is done in this type. The other variety includes several synthetic solvents, such as carbon tetrachloride. When laundries expand to handle drycleaning as well, they usually use synthetics because they are not inflammable and thus equipment can be installed without regard to zoning restrictions governing fire hazards. Drycleaning of high quality can be done with either type of solvent.

The garments are first carefully tagged and separated according to color and weight. Woolen jackets, for instance, are never cleaned with silk dresses. Next the clothes are placed in a drycleaning washer where they are immersed and agitated in a drycleaning solvent. To prevent loose soil from being redeposited on the garments, the dirty solvent is drawn from the washer at intervals and replaced by clean solvent.

Special soaps are used with the drycleaning solvent. They behave the way laundry soap does in water. When all possible soil has been eliminated, soap is removed from the garments by rinsing in more clear solvent.

Since drycleaning solvents are rather expensive, they cannot be discarded, but must be made clean and odorless again for the next load of garments. This is handled at the plant by filtration, distillation and extensive chemical treatment.

Practically all the drycleaning solvent is removed from the clothes in an extractor, where it is drawn off by centrifugal force. By circulating warm, fresh air through a tumbler, the last traces are evaporated.

Spots Removed Separately

Although soil of a greasy, oily nature is removed by the solvent, spots from some foods, liquor, ink and medicine often remain and must be handled individually. Operators known as "spotters" look for remaining spots and stains, and select the proper method of removing them. The chief difficulty is not to find an agent that will remove the stain, but one that will do so without damaging the fabric and dyestuff.

In some cases the spotter uses an agent that will dissolve the staining substance. In others he lubricates the spot so it will skid off the fabric. Sometimes he must change the chemical nature of the spot before removal. The spots are never removed by rubbing, which may permanently damage the fabric.

Wet Cleaning a Last Resort

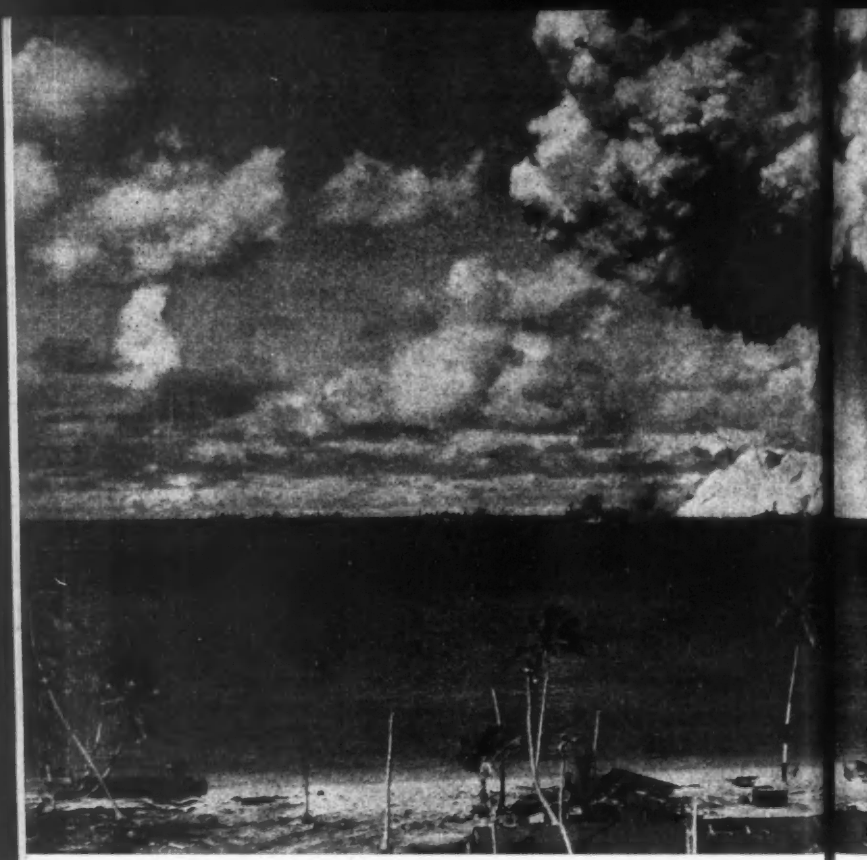
When a garment is so badly stained or so filled with embedded soil that drycleaning and spotting cannot refresh it satisfactorily, it may be cleaned in lukewarm soft water and the appropriate soap or detergent. As shrinkage is one of the great difficulties, garments are measured before and after wetcleaning. They are dried quickly by blowing warm air through them so the colors will not run.

In the finishing department apparatus of different types, sizes, and shapes is used to blow steam through the cloth. Pressure is avoided wherever possible in restoring the garment to its original shape. Sizing is restored to nets and other crisp fabrics with spray guns. To avoid shine, steam is shot through forms suitable for men's coats instead of pressing them.

The garment receives a final inspection before being put into the bag for delivery. In all, about 50 minutes of work is required for each garment to do a job of good quality.

Occasionally the cleaner receives complaints from the customer of imperfect cleaning, snags or loss of color. Several state and national associations maintain laboratories equipped to discover the cause of the trouble.

➤ SOMETIMES WET-CLEANING *is the answer to a spotty problem.*

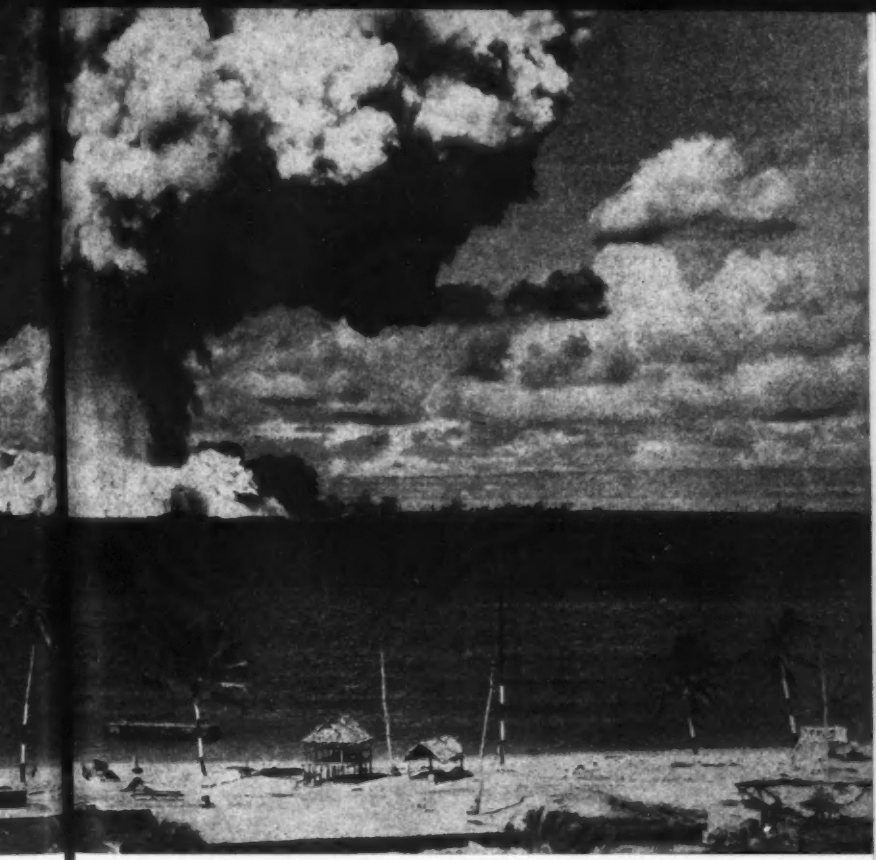


➤ THE PHOTOGRAPHER *might not have survived had this view of the explosion* [illegible]*ater automatic cameras left on the island. Photograph by Joint Army-Navy Tas*[illegible]

THE ATOM BOMB is a much more formidable weapon when exploded under water than it is when exploded in the air. This was made apparent by comparative pictures of Able and Baker tests, such as the photograph on this page.

Much of the motion picture footage was taken by automatic cameras on towers on the atoll's islets and on ships in the target array. The rest was "shot" from planes flying as close to the scene of the explosions as drone and piloted planes could get.

Within seconds after the explosion burst violently through the lagoon's



losion o ater bomb at Bikini been taken by a living operator instead of by one of the vy Tas

eras on and on The rest as close as drone

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surface, a dense white mist had risen to many times masthead height and completely engulfed the ships. Charged as it was with radioactivity of deadly intensity, this mist was far worse than any poison gas used in Flanders during World War I. No protective clothing or gas mask could prevent its lethal radiations from penetrating the flesh and bones of anyone on the decks.

At the same time, hundred-foot waves were started, that sent deluges of green water, also radioactive, washing over the ships. These waves subsided to a tenth of their height before

they had traveled three miles, but in the meantime they did their mischief. And even before they struck, the wracking shock wave had sped through the water like an earthquake, ripping hull plates open and starting even the stoutest of warships towards the bottom.

But of all the effects of this triple-threat weapon, radioactivity is by far the worst, in the opinion of Vice Adm. W. H. P. Blandy, Commanding Operation Crossroads. Terming the bomb a "most insidious weapon," he points out that its effects might be felt not only by its immediate victims but that its "untold harm" might extend into future generations.

Adm. Blandy wishes to see the atom bomb effectively outlawed, not by mere pious words of renunciation but with a ban backed up by effective international action. If we cannot get that, he is in favor of keeping the weapon and continuing research on it.

Size of the Atomic Bomb

➤ Two MORE BITS of information about the atomic bomb have been allowed to escape from behind the "iron curtain" of atomic energy secrecy.

The size of the critical mass of the atomic bomb, that is, the size that the active plutonium must be before it will go off explosively, is now known to be between 22 and 66 pounds. This has been stated in a British report.

Previously the limits were between 4.4 pounds and 220 pounds as stated in the famous Smyth report issued last August by the War Department.

The new minimum size of the bomb confirms the idea that not very much of the fissionable element is needed to make a bomb. The actual bomb may, of course, be much larger than the minimum amount necessary.

The other information is this: Another chain-reacting substance, probably an element, other than plutonium, can be manufactured. It can be made through use of uranium and thorium, but uranium is necessary to start with. This is the reason that the State Department report on international control of atomic energy proposed putting thorium as well as uranium under atomic control. The 235 isotope of uranium and the element pluntonium manufactured from uranium are the only two elements that hitherto it has been known could be made into atomic bombs.

Food Source

➤ THE WATERS of the south Pacific ocean may become one of the great food producing areas of the world as soon as scientific exploration gives enough facts about unexpected hints as to their possible productivity.

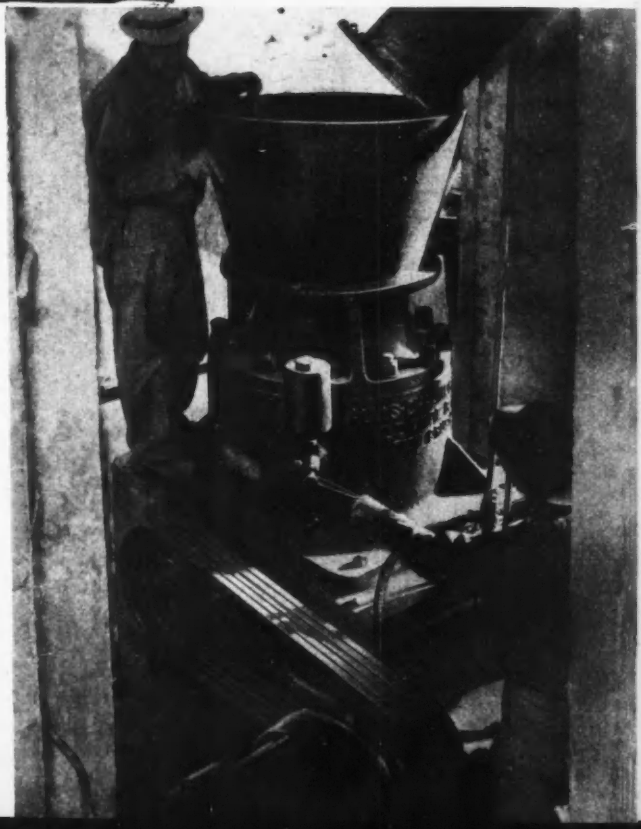
As the result of the Pacific Science Conference held in Washington recently, scientists are expecting to send expeditions to tropical sea areas traditionally considered less rich in fish and other life than the cooler waters of the world's oceans.

Grind

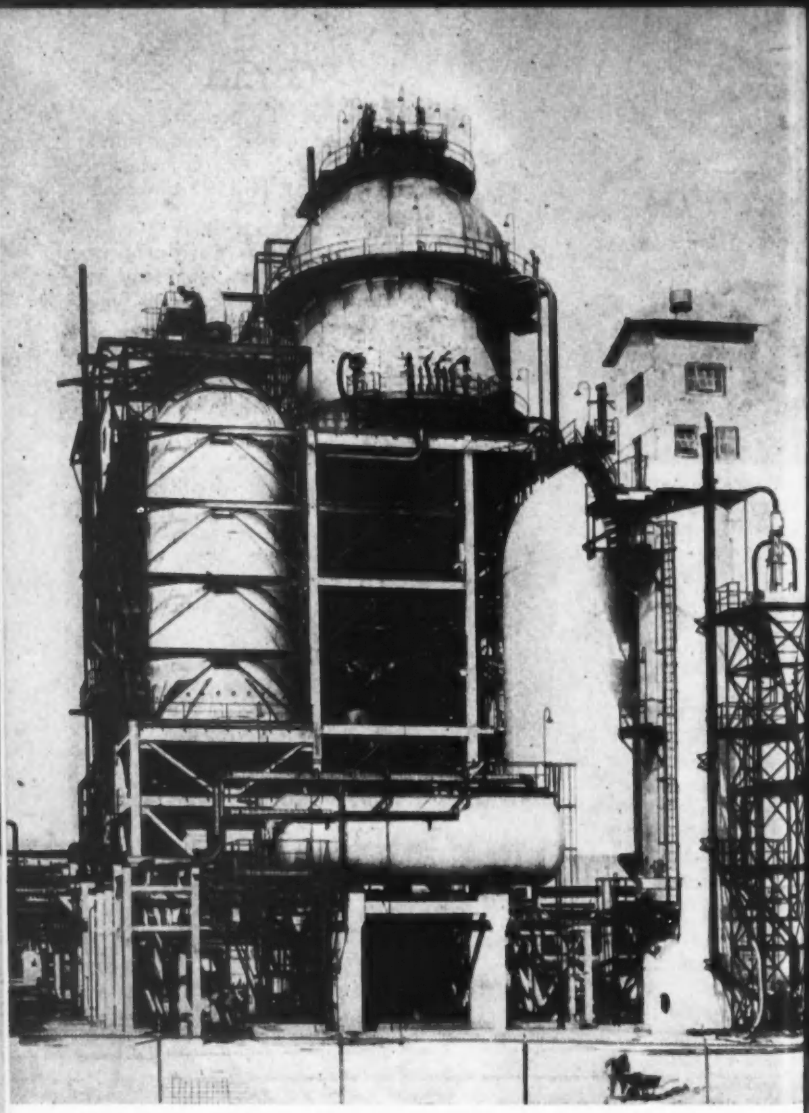
➤ LABORATORY DIRECTIONS call for material ground to a fine powder with a mortar and pestle. On the industrial scale, grinding is done by power-driven crushers.

Some material is powdered by pounding, some by crushing, some by rubbing, in man-sized machines similar to the one shown below.

THIS *is the first of a series of pictures showing how small-scale procedures of the laboratory are translated into plant-size apparatus.*



CRUSHER *installation by Allis-Chalmers of Milwaukee, Wis., at the Yosmite Cement Corp., Merced, Calif.*



▶ THE MAN *with the wheelbarrow, just behind the fence in the foreground, gives the scale of this cat cracker, which is no relation to a dog biscuit.*

Acetylene from Natural Gas

➤ ACETYLENE GAS, best known in America for its use in welding, may soon be commercially produced in this country from natural gas instead of from calcium carbide as at present. A German process of making it from coal gas is one of the important discoveries of American scientists investigating chemical secrets of former enemies.

In addition to its use in the oxy-acetylene flame for welding and cutting metals, acetylene is the starting point in the synthesis of a large number of organic compounds, and its manufacture in America was a $15,000,000 industry in prewar days. Acetic acid is made from it in great quantities by a catalytic hydration process. Acetic acid is well known in vinegar but its greatest use is in making plastics of the cellulose acetate type, including cellulose acetate silk, the best kind of rayon.

The German methods for deriving acetylene from coal gas are said to be more efficient than American processes. The United States has large quantities of natural gas, of which only a relatively small amount is now used for the production of chemicals. Chemists feel that the German methods are adaptable to the production of acetylene from natural gas, giving America another source of this increasingly important basic chemical.

Further investigation of the German process is now being made by American chemists overseas. The findings will be made public through the Office of the Publication Board, U. S. Department of Commerce.

In The Atlantic

➤ GEOLOGISTS are diving into the Atlantic off the Bahamas in hopes of finding oil. A two-ton diving chamber will be sunk in 20 feet of water while Standard Oil scientists measure the pull of gravity. Such values are used in predicting whether petroleum might be struck in underlying rocks if wells were drilled. A radar-equipped mother ship will locate the soundings exactly.

"Cat Cracker" Gives More Gas

➤ A "CAT CRACKER" that has nothing to do with cats or crackers squeezes an average of two gallons more gasoline out of every barrel of crude oil at the Texaco refinery at Lockport, Ill.

Developed to process high octane gasoline components for aircraft, the new multi-million dollar catalytic cracking unit has the largest fractionating tower ever used on a "cat-cracker."

Fifty-two men are required to operate the 12-story unit that now turns out 13,000 barrels of high octane automobile gasoline each day. Officials predict that the production rate can be upped to 20,000 gallons a day.

Daily Experiences Reinforce Science Learned in School

Science in Everyday Things

by SOPHIA M. MOILES

Miss Moiles is a teacher in the Johnstown High School, Johnstown, Pa., and chairman of the Junior Academy of the Pennsylvania Academy of Science. She is also sponsor of the science club in her school, which is affiliated with Science Clubs of America, the national organization administered by Science Service, as well as a SCA cooperator, stimulating the state-wide organization of science clubs.

➤ DURING the past four years our attention has been called increasingly to the importance of mathematics and physical science to the welfare and security of the United States. Our boys returning from boot camps, or longer service overseas, step into the physics classroom and, after greeting the teacher, exhort their younger friends to study the subject well. These boys often express surprise to find that the laws which they have learned in school are the same laws they are taught to apply in the army, the navy, and the air corps.

The emphasis thirty years ago was on chemistry, during this war it has been on physics, and now, as our knowledge of the nature of matter increases, the two are blending into one.

But is it necessary to go to war in order to see practical value in the study of physics and chemistry? Can we not draw countless illustrations of better ways of performing everyday acts through application of physical principles, or to justify the way in which we do perform these acts?

Why should not our classroom demonstration be of the simple type, closely related to life? I remember a music teacher, who was inclined to be artistic in other ways, bringing home a cuckoo clock, the kind with a pendulum. She looked carefully at the clock and decided the bob on the pendulum was not correctly placed from an artistic standpoint. She adjusted the bob accordingly. The next morning the clock was eight hours too fast. Yes, she had had physics. But would she have done this if she had been asked to count the vibrations of a pendulum which had been set swinging in class before her, and shortened as it swung, until the vibrations were so numerous that she could not count rapidly enough to keep up with them?

Another friend of mine with a better background in physics found herself with the aid of another woman trying to put the corner of a rug under a radiator. She tried lifting to no avail. She thought of waiting until her husband returned. Her helper would be gone then. She wanted the room in order that day. Then she recalled the lesson she had had on levers and promptly improvised one which served the purpose. She refers very proudly to the fact that she was able to put theory into practice.

A worm gear may not have interested a housewife ten years ago, but today many a woman cares for her own stoker. Every American is machine conscious, at home because he uses them, abroad because he misses many of them.

The shortage of fuel during the war years has brought home insulation and air conditioning to the attention of all of us. In one instance an old country house with second floor bedrooms which were too cold in winter and too warm in summer has been transformed from a liability, since it would not rent, into a very substantial source of income for its owner through insulation. Here, too, a knowledge of physics allowed the owner to decide where the insulation would be of greatest benefit, since complete insulation seemed too great an outlay.

Nor is it difficult to show someone with a knowledge of physics the value of storm windows for fuel conservation.

In both physics and health we are taught that low relative humidity in the home makes for increased rate of evaporation of moisture from the body and a desire for higher temperatures in the home which in turn increases still more the rate of evaporation. This should impress upon the housewife the need for water in the humidifying units of the furnace at all times, the value of plants in the living room, and other sources of moisture for our homes. We are told that it is not possible to keep the relative humidity as high in our homes in winter as in summer. True. But the more nearly we can approximate right conditions, the better. My own experience has been that my furniture does not warp or fall apart when I keep my window seat filled with growing plants. That it is possible to put too much moisture in the air through the humidifying devices on the furnace can also be demonstrated. The air near cold windows and walls becomes saturated and moisture condenses on them, often ruining wall paper and other interior decorations.

Even as our furniture warps from lack of moisture, so the lining of our noses and throats becomes dry and cracked in our overheated, too dry homes. Thus we prepare better breeding grounds for germs and increase our susceptibility to colds.

Many of us are building homes outside cities where water pumps must be used, and septic tanks installed, for sewage. I have one of these homes which I rent. One day my tenant came to me and complained that the one pump was not functioning properly. He said he had asked the person who had installed the pump to come out and correct the fault, but that he had refused. I asked to see the refractory pump. The man turned the fly wheel partly around and said, "See, every time it reaches this point it seems to stick." Yes, every time it reached that particular point it turned with difficulty, because at that point the water was being pushed into the pressure tank. Knowing pumps saved me an unnecessary call from the service man.

Many persons do not know that soaps and soap powders are good germicides. They are that for our hands and clothing, destroying most types of bacteria. But they also destroy useful

bacteria in septic tanks, as do many of our stronger disinfectants.

We may also learn to test our scouring powders for abrasives, to recognize the common acids and alkalies in use in the home, to know the solvents which best remove spots from clothing, the ways to bleach stains from various kinds of cloth, or how to select paint for a house.

Or perhaps we are interested in the problem of good home lighting? Last summer I attended summer school where I had a room furnished in dark oak with dark walls, two windows shaded with trees so that the only suitable light for reading came when I sat by the window, and then only when the sun was not shining because the flickering pattern of the leaves on my book was too distracting. Most of my studying was done as a result by artificial light. Can we not stress the importance of suitable light for reading and sewing in our homes? Even encourage the trend toward more window space, fewer draperies and curtains over the windows when we do have them, light colored woodwork, furniture and walls?

Do we teach the law of inverse squares in terms of the distance from the lamp to Johnnie's book? Do we have our lights so arranged in our schools that the dark side of the room may be lighted without turning on the lights nearer the windows? I have used a light meter on the seats in my classroom and have found that those furthest from the window may be getting as little as 6 foot candles, while the light on those near the windows is as high as 50 foot candles.

Most of us at sometime or other have owned an automobile. Here a knowledge of physics often saves time and trouble. After a warm, humid spell in the fall the temperature suddenly drops and the car refuses to start. We check the gas, the tank is full. The battery turns the motor with ease. But what of the spark plugs? They have been cooled below the dew point and are covered with a thin film of moisture which allows an electrical discharge to take place outside the cylinders and prevents the voltage between the terminals from becoming high enough for a discharge to take place there. The gas in the engine is not ignited and the motor does not start. Wiping the spark plugs with a dry cloth is often all that is necessary, or perhaps lifting the distributor cap and drying it.

Many of us do not have our motors tuned before cold weather comes and are inconvenienced again. If we are taught the importance of good clean electrical contacts and good insulation we shall not need to be urged to have the pitted, corroded contacts removed from the distributor to allow a freer flow of current during the cold weather, nor shall we be surprised that the garage mechanic advises a new condenser to give the best conditions for the voltage to reach the desired level.

If we handle a carburetor are we not more aware of the delicate needle valve through which the gas passes to the venturi tube, and more careful about letting dirt and water get into the gas tank? We learn that the surface tension of water is much greater than that of gasoline or alcohol so we understand why a drop of water in the needle valve may effectively stop the

flow of gasoline. We know, too, that alcohol in water reduces this surface tension, and incidentally the freezing point of the mixture, so we are quick to put a quart of alcohol in our gas tank in case water or snow in small quantities has entered.

Speaking of surface tension again, that of most anti-freeze solutions is less than that of water. Therefore we must have the hose connections checked before putting anti-freeze mixtures in the radiator if we have been using water during the summer, else we may find several dollars worth of good liquid having leaked out over night.

When we realize the pressure that results from the burning gasoline in the cylinders we understand the importance of well-seated valves. Smoke from the exhaust indicates incomplete combustion and inefficiency. Sun on the tires hastens chemical action which causes deterioration of the rubber. Riding the clutch wears away the friction surface between it and the fly wheel.

An oil gauge which registers zero means the oil is not circulating. Lack of oil means friction and heat which soon wears away the parts. Good oil means two things: adhesion to parts of the machine, and a high kindling temperature. Distilled water is used in the battery to prevent local action. The lead sulphate which is deposited on the battery plates when they are out of the liquid does not redissolve when the plates are again covered. In other words the area of the battery plates has been reduced by the amount that has been sulphated. These are just a few illustrations of information which may be acquired in a science class which should be of practical value in guiding the automobile owner in the care of his car.

This you may say is all very good, but why teach such abstract ideas as Newton's Laws of Motion, center of gravity, moments, kinetic energy or simple harmonic motion? Only a few ever will use them. Or perhaps you will admit that the law of inertia is useful, if one thinks in time to apply it. Certainly a driver on an icy or muddy road knows that he is sometimes better off if he can avoid stopping. The baseball player and the golfer learn that the momentum given a body is a product of the force applied by the time during which it is applied, and follow through. The pole vaulter is taught to roll over the pole and allow his center of gravity to pass beneath. The football player increases his stability by placing his feet farther apart thus increasing his base, and stooping to lower his center of gravity. One large industrial concern tests its truck drivers' knowledge of center of gravity, centrifugal force, and stable equilibrium before hiring them. The advantage in every lever depends upon the relative distances of the effort and the resistance from the fulcrum. All of these practical applications can give life and meaning to the so-called abstract ideas.

Charts are sent out by automobile manufacturers which show the distance a car will travel after the brakes are applied depends upon the square of the velocity with which it is traveling, or in other words depends upon its kinetic energy. This chart I have found one of the best methods of teaching safe driving practices. Re-

search also will show the mileage obtained from the gasoline consumed and the life of the tires both vary inversely as the square of the velocity.

Simple harmonic motion as seen in the pendulum gives any teacher excellent opportunities to teach wave motion and the vocabulary used in the study of sound, light, and radio. This brings us to the last, and to me one of the most important values in the study of science, the cultural value. Increasing our fund of facts and our vocabularies is a prerequisite to intelligent action in the world of today.

With the dropping of the atomic bomb on Hiroshima, a new interest in chemistry on the part of the layman has been aroused. Since that time newspapers, magazines, books and the radio have been diligently endeavoring to make all of us aware of the structure of matter and the relationship between matter and energy. Our Congress has been called upon to enact laws controlling our research laboratories and our scientists. The public has been invited to participate in the discussion and have a part in the responsibility for any legislative action to be taken. We have been made more conscious of the research done in other countries and of our dependence upon their scientists than ever before. Let us hope, too, that we are intelligent enough to know that no legislative control over the thoughts of scientists will ever solve any of our problems. That it is only through an honest search for the truth, come what may, that any true progress results.

Science is found in everyday things. The background with which to enrich our teaching is ever present; it is only waiting for us to make the interpretations.

Palatability Vitamin Discovered

➤ A PALATABILITY VITAMIN was reported by A. M. Hartman and C. A. Cary, of the U. S. Department of Agriculture, at the meeting recently of the American Dairy Science Association. The new vitamin's only name, so far, is Nutrient X, signifying that scientists do not yet know its chemical nature.

It is found in several milk products, lettuce, egg yolk, beef and pork muscle, alfalfa and blue grass and alfalfa and timothy hays. It is not present in whole wheat flour, white flour, enriched white flour, yeast, cornmeal, soybean oil meal, linseed oil meal or heat coagulated egg white. Liver etract used in treatment of pernicious anemia is a rich source of Nutrient X.

The palatability which it confers on diets is not just a matter of taste of food items but of the body's needs for, and use of, the particular food.

Answers to Chem Quiz on Page 27

1. First: Ca in CaO; second: CO_3 in Na_2CO_3; whole: $CaCO_3$.
2. First: hydrogen; second: cyanogen; whole: HCN.
3. First: ethyl; second: OH; whole: ethyl alcohol, C_2H_5OH.
4. First: uranium; second: fluorine; whole: UF_6.

Interesting Chemical Angles in Newly Issued Patents

Chemical Patents of the Month

New methods for standard materials, as well as novel substances, are featured. Copies of patents may be ordered by number from the U. S. Commissioner of Patents, Washington 25, D. C. Enclose 25 cents (not in stamps) for each patent.

▶ CHLORINE, that poisonous green gas that is as necessary to many industries as gastric juice is to human physiology, can be made copiously and cheaply by a new process on which U. S. patent 2,401,644 has just been granted to a du Pont research chemist, Dr. Ralph K. Iler of East Cleveland, Ohio.

Raw materials are sulfur and common salt. The sulfur is burned, producing sulfur dioxide. To this more oxygen is added, forming sulfur trioxide. The trioxide is brought into contact with fine-grained salt, at a temperature between 450 and 600 degrees Centigrade. Part of the sulfur is seized upon by the sodium in the salt, forming sodium sulfate, which is removed.

From this reaction comes a mixed gas, containing chlorine and sulfur dioxide in equal quantities. This gas is then passed through dry silica gel, which adsorbs most of the sulfur dioxide. The rest is taken out by contacting the gas with activated carbon or other catalyst, which combines it with part of the chlorine to form sulfuryl chloride, and holds it in liquid form on the carbon.

The chlorine, now in substantially pure state, is drawn off and prepared for industrial use. The sulfuryl chloride, subsequently recovered, is broken down again to sulfur dioxide and chlorine by heating, and these gases are fed back into the process.

Sweet-'Tater Crispies

▶ THREE ALABAMANS, L. M. Ware, Hubert Harris and W. A. Johnson, have undertaken further to glorify that glory of the South, the sweet potato. Peeled, finely-cut roots are first steam-blanched, during which process their natural sugar content is about doubled by conversion of starch. Then they are dehydrated down to about 20% water content.

This stiff paste is extruded through a ricer, forming it into grains, ribbons or any other desired shape. Finally, this finely divided material is toasted to crispness in an oven. The product may be eaten like breakfast food, or have further flavor added in the form of coconut, pineapple, banana, etc.

The three inventors have assigned rights in their patent, No. 2,401,392, to the Alabama Polytechnic Institute.

Shredded Cheese

▶ CHEESE CAN NOW be dehydrated in shredded or pelleted form, without loss or deterioration of its original fat content, by a process developed by Dr. George P. Sanders, of the U. S. Department of Agriculture. Essential first step is to drop the finely divided cheese through a current of warm air.

After that, dehydration can safely be finished at higher temperature. Simply adding water reconstitutes a sliceable cheese. Dr. Sanders' patent, No. 2,401,320, is public-dedicated.

Fluorescent Sulfur

➤ ULTRAVIOLET RADIATION is used to detect sulfur in coal by its fluorescence, in the method on which patent 2,401,410 was issued to Walter T. Brown of Pittsburgh. The lamps may be mounted on the cutting machine, to find the sulfur spots while the coal is being mined, or they may be suspended over a conveyor carrying lumps to the tipple. Sulfur-free coal is needed for metallurgical work, coal containing sulfur may be used for less critical purposes.

Locating Buried Objects

➤ WHEN INDIVIDUALS want to locate a non-metal object hidden in the earth, or an Army wants to remove land mines buried by itself, it can be done by an apparatus just patented, provided a small quantity of a radioactive substance was buried with the object. This may be in the paint used to coat the container. The invention was made by Joseph Horace Deming of Houston, Texas, and it has been assigned to the Texaco Development Corporation. The award is patent 2,401,723.

The device consists of a battery, condenser, headphones and a radiation detector or counter of a simplified Geiger-Muller Type. In operation, the user, wearing the headphones, carries the equipment around in the vicinity of where he expects to find the hidden object. When he locates the point of highest intensity of radiation he knows he is about directly over it.

Machine Handles Plastics

➤ WITH THE INCREASING use of plastics in all kinds of shops, operators will be interested in a machine for compressing and heating electrically thermoplastic materials. It is an English invention on which U. S. patent 2,401,991 has been granted.

It is a rather simple machine for jointing strips of thermoplastic insulating material by heating the overlapping ends by subjecting them to a high-frequency electric field and compressing them to weld them together.

The patent has been assigned to the British Insulated Cables Limited, Prescot, Lancashire, England, by the inventors, George Hall Walton and Joshua Creer Quayle, both of Helsby, and Peter Jones of Kelsall.

Rotary Combustion Engine

➤ AN INVENTION having to do with new and useful improvements in rotary combustion engines is of interest in the power field. This type of engine has circular housing and an eccentrically mounted piston which rotates within the housing by means of explosive discharges against vanes movable radially in the piston.

The recipient is Everett William Rich, San Diego, Calif., and the patent awarded is 2,402,257. An important improvement in the present invention is a novel arrangement of rotary valves for controlling the supply of explosive charges to the power and pump chamber for compression, the passage of the compressed charges on to the combustion chamber of the engine head, and also the passage of the expanded fired gases from the combustion chamber to the power

and pump chamber for driving the piston of the engine.

Tin Plating by Electricity

➤ TIN PLATING of sheet metal, to be used in making the familiar "tin cans" and for other purposes, was carried out for years by the so-called dipping process. During the war a process of applying the tin in an electrolytic bath was developed and used largely because a thinner coat could be applied and less of the critical metal used. A patent, 2,402,185, on one electroplating composition and process has been granted to Ernest W. Schweikher, Shaker Heights, Ohio, assignor to the E. I. du Pont de Nemours and Company, Wilmington, Del.

For electroplating, compositions in which the tin is in a stannous compound are found satisfactory but these compounds are not stable or, if dry, become partly insoluble in storage. This patent is given for a mixture of stannous tin and smaller quantities of other chemicals that increase stability and produce no undesirable effect upon the tin deposits. A dry composition included is 66% stannous chloride and 33% sodium fluoride, the remainder being equal amounts of potassium ferricyanide and sodium thiocyanate.

Two Chemical Processes

➤ AMONG THE CHEMICAL processes patented are two of particular interest. One includes a procedure for incorporating special modifying materials with paper pulp to impart novel wet strength and other desirable properties to paper. The other has to do with the manufacture of activated carbon.

The first is a method of making fibrous material by incorporating into it water-swollen particles of polyvinyl alcohol, from which impurities tending to cause frothing and which are soluble in water below 50 degrees Fahrenheit, have been removed.

The polyvinyl alcohol is soluble in water at temperatures above 130 degrees, and form a web in which the fibers are felted together. After proper heat-treatment its particles are plasticized and set into masses which are elastic when moistened.

The activated carbon manufacturing process, it is claimed, gives a product superior to those obtained by ordinary methods. It includes a method of separating the finely divided carbon particles in accordance with their relative densities so that a product is obtained with increased adsorptive activity.

William Craig Toland, Brookline, Mass., and Benjamin B. Burbank, Brunswick, Me., were granted patent 2,402,469 on the paper process; and Alan C. Stoneman, Los Angeles, was awarded patent 2,402,304 on the method of making activated carbon.

Silicon Patents

➤ THE INCREASING USE of silicon materials from sand in industrial applications has resulted in processes for their improvement. Patent 2,402,582 was granted to Jack H. Scaff, of Madison, N. J., for methods and apparatus to prepare highly pure silicons in forms for purposes of modification, rectification or detection of electric currents.

The results of his methods are silicon materials in certain physical forms that possess remarkable electrical,

thermoelectric, and photoelectric properties. The patent has been assigned by the inventor to Bell Telephone Laboratories, Inc., New York City.

The process comprises adding to extremely pure silicon a small amount of silicon carbide which yields to the pure silicon enough carbon to constitute about 0.1% of the whole. After heating to a temperature substantially above the fusion point, it is cooled at a rate of approximately 100 degrees Centigrade a minute that causes it to solidify in an orderly manner.

Sulfuric Acid

➤ SULFURIC ACID manufacture, and apparatus for the process, was granted patent 2,402,553 to David M. Hurt, Wilmington, Del., George S. Stafford and Ernest J. Tauch, both of Cleveland Heights, Ohio. The rights have been assigned to E. I. du Pont de Nemours and Company, Wilmington. In reality it is a process of making sulfur trioxide from molten sulfur.

The invention relates particularly to methods of filtering the molten sulfur to remove solid matter that may be contained so that a pure end-product may be obtained. The apparatus contains two filters for liquid sulfur, a sulfur burner, a catalytic converter, a conduit between the filters, and other necessary parts. If the second filter becomes clogged with an undue amount of solid impurities, the rising level of the molten sulfur operates an alarm system.

Nitric Acid

➤ AMONG NEW CHEMICAL compounds and new processes of manufacturing chemicals, one of particular commercial value is for the concentration of nitric acid. The patent, 2,403,050, was granted to Francis Stapleton Chambers, Jr., Woodbury, N. J., and Robert Nifong Gartside of St. Louis. DuPont has acquired the rights by assignment.

The method is a two-step process. The first involves the distillation of strong nitric acid vapors from a mixture of sulfuric and nitric acids. The second involves using the residual acids from the first stage, causing them to pass down dehydrating and fractionating columns in which the remaining nitric acid is driven off in the form of strong vapors.

New Lubricants

➤ LUBRICATION and anticorrosion preparations received several awards among which is one, 2,402,969, granted to Rush F. McCleary, Beacon, N. Y., and another, 2,403,067, to Paul W. Fischer, Long Beach, and Vance N. Jenkins, Palos Verdes Estates, Calif. The first has been assigned to the Texas Company of New York, and the second to Union Oil Company, Los Angeles.

The McCleary composition is largely mineral or hydrocarbon oil to which is added a small amount of an aliphatic-ether-alcohol and ether-metal alcoholate derived from oils extracted from the cashew nut. The other, particularly applicable to turbine lubricating oils, is a mineral oil with an additive, primarily an oil-soluble fatty acid amide containing an alkyl substituent.

Acetaldehyde Process

➤ WITH THE INCREASING industrial use of acetaldehyde, patent 2,403,958 is of interest. It involves a continuous process of producing this chemical by

passing a mixture of steam, air and acetylene over inert porous material impregnated with a catalyst containing mercuric sulfate. The patent was granted to Alfred R. Globus, Brooklyn, N. Y.

Gas-Filled Electric Cable

➤ AN ELECTRIC CABLE that floats on water while carrying heavy currents to operate machinery on boats, rafts or islands, is one of the interesting new inventions.

Ordinary cables are heavy and sink to the bottom unless strung on poles or floated on a series of rafts. This cable is buoyant because it has a core of cellular material, that is a material containing thousands of tiny gas-filled non-communicating cells. The conducting metal is stranded or braided about this core. Between the core and conductor is a rubber skin impermeable to gas, and outside the conductor is heavy rubber insulation.

The method of gas-filling the core is unique. The core is usually made of rubber into which a gas-producing material is mixed before vulcanizing. When the rubber compound is being vulcanized by heat, gas is formed and remains within the core in tiny cells separated by thin rubber partitions. If the walls of the cells break, the gas is confined within the surrounding rubber skin.

Patent 2,403,693 was granted James Urmston, Montclair, N. J. for this invention. It has been assigned to Callender's Cable and Construction Co., Ltd., London, England.

Hydrogen Chloride

➤ A CONTINUOUS PROCESS for making hydrogen chloride, a gas which when dissolved in water yields the widely used hydrochloric acid, follows a method of intercombustion of chlorine and natural gases present in oil field and petroleum refinery locations It yields an anhydrous product for industrial uses.

Patent 2,403,735 was granted to Ralph Burgess Mason and Jerry A. Pierce of Baton Rouge, La., on the method of manufacture, and they have assigned their rights to the Standard Oil Development Company.

The preparation of hydrogen chloride by the reaction of chlorine and methane in the presence of air is not new. In this new process the gases react in absence of air, resulting in an anhydrous product of high purity and high concentration.

In this method the chlorine and natural gases are first preheated, then they are brought together at a burner and the combustion products held at temperatures between 1,200 and 2,000 degrees Fahrenheit for a short period of time. Under these conditions the gaseous hydrocarbons and chlorine form hydrogen chloride and carbon almost quantitatively.

Concentration of Iron Ore

➤ AN IMPROVED METHOD for concentrating iron ore was awarded patent 2,403,481. Julius Bruce Clemmer and Carl Rampacek, Tuscaloosa, Ala., received the award and assigned their rights to the United States government. It is a froth flotation process.

The process employs fatty acids and resin acids as anionic collecting agents to effect flotation of activated silica and siliceous non-metallic constituents from caustic alkaline iron ore pulps, while retarding flotation of the iron

oxides with ligninsulfonates. The anionic agents are materials such as the higher fatty acids, resin acids, mixtures of fatty and resin acids, and soaps thereof. The process can be used also with calcareous iron ores containing siliceous materials.

Gas in "Upside Down" Wells

➤ OIL WELLS in which the bore turns and starts back towards the surface after the oil-bearing stratum has been reached promise more complete extraction of their liquid wealth, according to the terms of U. S. Patent 2,404,341, just issued to John A. Zublin of Los Angeles.

Two conditions are necessary for the functioning of such a well, the inventor states: a considerable natural gas content dissolved in the oil, and an upper impervious layer preventing the escape of the gas after it has come out of solution.

Machinery for the drilling of deviating bore-holes has already been invented, Mr. Zublin declares. Holes can be drilled from near the bottom of a vertical bore, curving downward and sidewise at first, then turning sharply upward. Oil entering these "upside down" bores releases its natural gas and flows toward the main bore; the released gas joins the natural gas already present above the oil layer and helps it to push the oil toward the well, in what is known as a gas cap drive.

Electrolytic Mining

➤ NATIVE COPPER, which means practically pure metallic copper occurring in masses underground, is most exasperating stuff. It is highly valuable, of course, but is almost impossible to mine by ordinary methods because of its toughness. Paul W. Arvidson of Needles, Calif., gets around the difficulty by dissolving it electrolytically; patent 2,404,206 has been granted on his method.

First he manages to gouge a hole in the stubborn copper mass. In this he sets up his cathode, and into it pours a solution of copper sulfate and sulfuric acid; the mass of native copper itself acts as the anode. The electric current carries copper from the mass to the cathode, where it is deposited as loosely adhering flakes. These are constantly loosened and carried away by a jet of liquid playing on them. The liquid is passed through a filter where the flakes are removed for washing and melting down into bars.

Heat-Peeled Vegetables

➤ POTATOES, CARROTS and other vegetables can be peeled in great quantities, for dehydration, canning or other processing, by brief exposure to high radiant heat, states a U. S. Department of Agriculture scientist, George T. Hemmeter of Berkeley, Calif., in his preamble to patent 2,403,923. The heat literally cooks the skins off them, leaving the rest of the flesh unaffected.

His invention is an oil-heated, brick-lined furnace, through which the vegetables are rolled by a spiral fin mounted on a long cylinder. Their rate of travel is so adjusted that they get just the right amount of heating-up to peel them properly.

Rights in the patent are assigned royalty-free to the government.

Chemical Things To Do

Film Used To Duplicate Letter

by Joseph H. Kraus

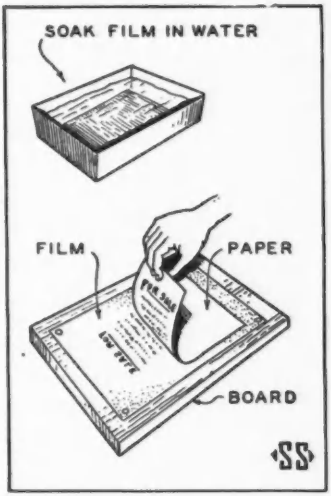
➤ The hectograph or copygraph, as it is sometimes called, has long been used to make duplicates of typewritten matter, drawings or handwritten copy. The most important part is a spongy pad of varying proportions of glue, gelatin and glycerine, but photographic film can be used in making a substitute.

Any piece of old photographic film, either exposed and developed, or preferably unexposed, can instantly be converted into a hectograph. Merely soak the film in cold water until the emulsion is soft and swollen. Thumbtack this film, sticky side up, to a flat wooden block. Gently blot or sponge the water from its surface and your "pad" is ready for use.

Now prepare the copy you want to duplicate by making your sketch, writing or typewritten material; glossy paper is preferable. Any color of hectograph ink, available at most stationery stores, can be used, but you must use hectograph ink.

After your copy has dried, place it face downward on the film. Holding it firmly so that it does not shift, smooth the copy into good contact with the film, using your fingers or the bowl of a spoon. Leave the copy there for five to ten minutes. When you peel off the drawing, you will see your copy in reverse on the film.

Use for your duplicates ordinary typewriter paper of a poor grade.



Dampen one sheet slightly by sponging it with water. Press the moist sheet down on your prepared film. Lift one corner and peel it off carefully. You will find a reproduction of the original copy.

Make Many Copies

A dozen or more reproductions can be made in this way, one at a time, from the original. After you have enough copies, place the film back in the water to wash off the old copy. The same film can be used again and again for new copies or more reproductions, and the same original can be used for a second or third impression.

Before carbon paper was invented, duplicates of typewritten letters were made with the aid of the hectograph. For many years restaurants have used the hectograph process to reproduce the day's menu. Today duplicates of important drawings are reproduced by a modern version of this process.

Your substitute hectograph can be used to make announcements of club meetings, invitations and special tickets. If you don't have an old piece of film which is large enough, your local photographer undoubtedly will be glad to give you an old discarded negative, or you may get one from an X-ray laboratory which uses films of large size.

Insulation for Magnet Coils

➤ FIBER GLASS in silicone resin makes satisfactory electrical insulation in magnet coils, it was reported to the American Institute of Electrical Engineers by Graham Lee Moses, of Westinghouse, and Julius J. Torok of Corning Glass Works.

The insulation of magnet coils presents problems different from those of rotating machines. Messrs. Moses and Torok reported on recent tests made by them to help solve these problems.

"The combination of fiber glass and silicone resin makes an important contribution to improving the thermal life of magnet coil insulation," they said. "The end of the reliable life of such coils is believed to be determined by the failure of the silicone resins as bonds. The glass fibers provide positive turn separation and the by-products of silicone decomposition are non-conducting."

"Silicone insulated magnet coils employing fiber glass insulated wires can be rated at temperatures appreciably above the 160 degrees Centigrade temperature by resistance proposed for silicone insulation on rotating machinery."

Goat Leather Replaced

➤ FIBER GLASS impregnated with synthetic rubber is replacing sensitive goat leather in diaphragms used to record very slight changes of pressure.

Impervious to gases and vapors, resistant to alkalis and acids, guaranteed not to sag or stretch, glass fibers treated with neoprene wear better than previously available material. A synthetic product, its quality can be controlled, whereas the wearing ability of the hides of Himalayan goats, formerly preferred for diaphragms, is unpredictable.

This flexible, highly sensitive material is used to record slight changes in pressure. The maximum deflection of the diaphragms used by the Askania Regulator Company, instrumental in developing the material with the cooperation of Owens-Corning Fiberglas Company and The U. S. Rubber Company, is usually less than 0.02 of an inch. But further investigation is needed, company officials point out, to determine whether this material is satisfactory for use in diaphragms in which the pressure changes are greater.

Diet and Disinfection
Chemical Problems at Home

Points on Care of Sick

by JANE STAFFORD

▶ IF YOU ARE taking care of a sick person, whether child or grown-up, at home, the doctor may give detailed directions about the diet, or he may order a "liquid" diet, a "soft" diet, or a "light" diet. It will help him and you if you know what is included in these different types of diets. The American Red Cross, in a newly issued Handbook for Nurses on disaster preparedness and relief duty, has a table showing the foods for each diet.

The liquid diet, as you might expect, is made up of liquids. Included are: strained fruit juices, milk, cream, malted milk, buttermilk, eggnog, clear broth, beef tea, well strained soups, strained vegetable juices, vegetable soups and creamed soups. Also included, for breakfast cereal, are thin gruels well cooked and strained.

Soft Diet

On the soft diet the patient may have besides the well cooked and strained cereals, spaghetti, macaroni, noodles and rice. He may have day-old or toasted white bread and soda crackers. Besides strained fruit juices he may have cooked fruits without seeds, coarse skins or heavy fiber, and well-ripened bananas. Cottage cheese and butter or fortified margarine may be given as well as milk and cream. Eggs may be served soft cooked, poached or soft scrambled without fat as well as in eggnog. Rice and noodles can go into the clear broths and soups and he may, if the doctor permits it, also have tender white meat of chicken, fish and lamb. Baked, boiled, mashed, creamed and scalloped potatoes and pureed cooked vegetables are also on the soft diet.

The light diet includes the soft diet items as well as the following: well cooked cereals and prepared cereals; all bread other than hot bread; fruit juices; citrus fruits and all cooked or canned fruits; cream cheese and other soft, mild cheeses; eggs in any form except cooked in fat or fried; all poultry, liver, crisp bacon, broiled lamb chops and ground beef, steak and roast; all vegetable soups, cooked vegetables that are young and tender without tough skins, and lettuce and tomato salad if the doctor does not forbid it.

To Kill Germs

Methods of disinfection for checking the spread of contagious diseases have changed from the days when grandmother waited till the patient got well, then shut up the sickroom and burned sulfur candles in it for days.

Today health officers advise disinfecting as you go along. The idea is to catch and kill the germs before they get started spreading disease to someone else. This means having the

patient use paper handkerchiefs which can be promptly destroyed, disinfecting his eating utensils and dishes after every meal, boiling night clothes, sheets and the like, or soaking them in disinfecting solution, as soon as they are removed from the bed, and so on.

All of this helps check disease spread but it makes quite a problem for mother if Johnny is nursed at home when he has scarlet fever or some other catching disease for which these measures are needed. It even makes problems in hospitals. Wool blankets and robes cannot be boiled without shrinkage, colored garments cannot be boiled without danger of fading or having the colors run, and some disinfectant solutions also bleach which is hard on colored garments.

Laundries Can Help

The health department of the State University of Iowa, however, has worked out a solution to the problem by making use of commercial laundries. The same method, described by Dr. M. E. Barnes in a report to the American Journal of Public Health, could be used in any community where the health department sets up the necessary arrangements.

The procedures commercial laundries use to make garments clean and attractive, Dr. Barnes points out, are also highly effective in destroying disease germs. The hot water and bleaching used for laundering bed linen and white clothes, the sudden change from extreme alkalinity through the "souring" process, the hot air in fluff-driers and the moist heat during ironing all will kill disease germs.

If you have a case of "catching" sickness at home, ask your health department whether arrangements have been made for your laundry to handle the linen safely.

Cream Stays Fresh and Tasty for Year

➤ Processed cream will be fresh and tasty after being kept at room temperature for a year or longer, thanks to a new method which sterilizes the cream. Developed during the war for the armed forces overseas, the new method results from six years of research by the California Milk Products Company, Gustine, Calif.

Only four minutes is needed to process the product, known as "Avoset." Instead of being pasteurized (unsuitable for such a process because it does not kill all bacteria) which requires that the cream be heated at 145 degrees Fahrenheit for 30 minutes, the mixture is preheated and sterilized at temperatures varying between 260 and 280 degrees Fahrenheit for about four minutes.

Prior to processing, a small amount of vegetable "stabilizer" is added to the sweet, fresh cream, to keep the milk solids in the finished product from separating out on long storage. After sterilization, the mixture is rapidly cooled and passed into a sterile holding tank, ready for bottling.

Air in the bottling and capping room is kept virtually free of dirt and bacteria by the Precipitron, an electrical air cleaner.

The Rare Earths Yttria and Ceria Begin Spawning New Elements

Lanthanum and Didymium Erbium and Terbium

A Classic of Chemistry

THE DISCOVERIES of the two first-found elements from which the rare earths were later separated appeared as the Classic of Chemistry in the March, 1946, issue of this magazine. The elements were yttrium and cerium, both occurring in Sweden but in different minerals from different locations. Analysis of rare Swedish minerals provided a fascinating puzzle for chemists for more than a century, and resulted in the development of schemes for systematic analysis, as well as the discovery of many new elements. In this paper, C. G. Mosander describes how he found two new elements associated with each of the parents of the rare earth series. Didymium persisted as one element for forty years longer before it was split into Neodymium and Praseodymium. Other steps in the discovery and understanding of the rare earths will appear as Classics in future issues of CHEMISTRY.

Lanthanum

ON THE NEW METALS, LANTHANUM AND DIDYMIUM, WHICH ARE ASSOCIATED WITH CERIUM; AND ON ERBIUM AND TERBIUM, NEW METALS ASSOCIATED WITH YTTRIA—*by Prof. C. G. Mosander*. In Philosophical Magazine, 3rd series, Vol. 23, No. 152. October 1843.*

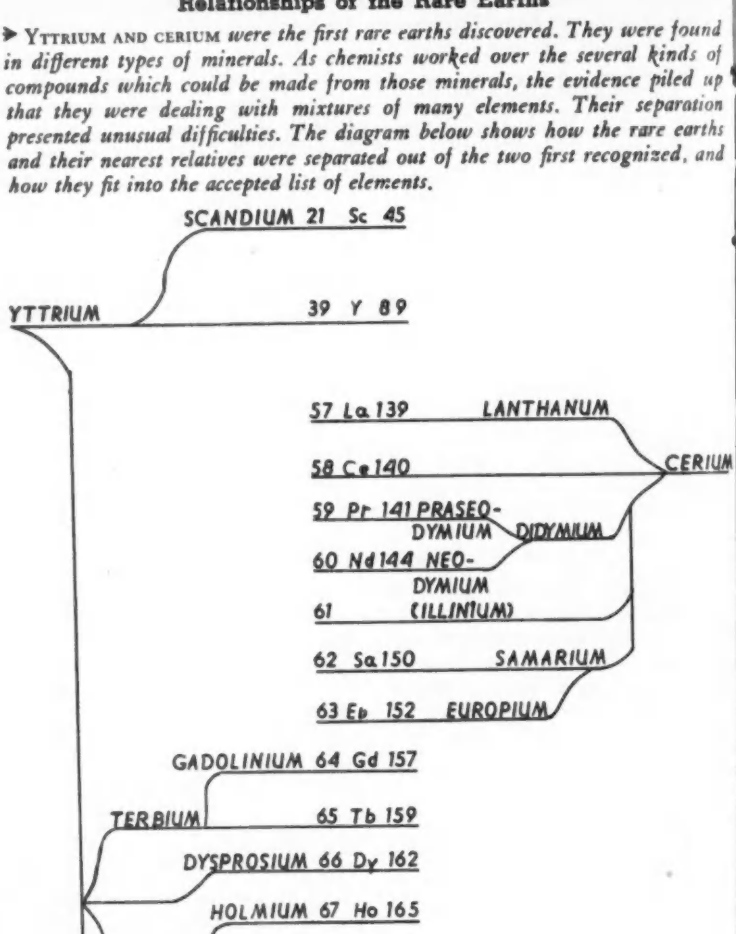
ALTHOUGH IN CONSEQUENCE of the imperfect nature of the results which were obtained from my researches on cerium and lanthanium I had no intention of making any communication on the subject on the present occasion, yet after hearing the interesting statement of Professor Scheerer, it appeared to me that it might be useful to make known more generally some particulars which arose during my labours, and principally because this advantage may result, that other chemists, after becoming acquainted with what I am about to state, may possibly be spared the loss of valuable time which might otherwise have been fruitlessly expended.

When sixteen years since I made some experiments upon cerium, several circumstances occurred which led me to the supposition that oxide of cerium was accompanied by some other oxide, which, however, I did not succeed in separating, and want of

*Communicated to the meeting of the Scandinavien Association at Stockholm, July 1842. Translated from the Swedish by Maj. North Ludlow Beamish, F. R. S., President of the Cork Scientific and Literary Society; and read before the Section of Chemistry and Mineralogy of the British Association, meeting at Cork, Aug. 18, 1843.

Relationships of the Rare Earths

▶ YTTRIUM AND CERIUM *were the first rare earths discovered. They were found in different types of minerals. As chemists worked over the several kinds of compounds which could be made from those minerals, the evidence piled up that they were dealing with mixtures of many elements. Their separation presented unusual difficulties. The diagram below shows how the rare earths and their nearest relatives were separated out of the two first recognized, and how they fit into the accepted list of elements.*



materials prevented me from then prosecuting the inquiry. A few years since, having procured a quantity of cerite and cerine, I prepared from thence the double salt of sulphate of the oxide of cerium with sulphate of potash, which salt was washed with a solution of sulphate of potash, until the passing fluid gave no trace of precipitate with caustic ammonia or carbonate of soda. I believed that in this manner I could obtain a pure salt free from all foreign substances. The double salt was afterwards decomposed in the moist way with carbonate of soda, and with the carbonate of protoxide of cerium thus obtained, all the preparations have been made which will be now mentioned.

After a long examination of various salts of protoxide of cerium, I did not succeed in detecting a salt principally consisting of the supposed new oxide, the presence of which, however, appeared more and more probable in the course of the experiments. As it was known that cerium gives two oxides, I considered it probable that if hydrate of protoxide of cerium mixed with water was exposed to the effect of chlorine, peroxide of cerium would be formed while the more electro-positive metallic oxide would be dissolved in the fluid, and it was in this manner that I succeeded to my satisfaction. When the chlorine was introduced into the fluid, the appearance of the hydrate of protoxide of cerium began soon to change, the volume diminished, and a heavy, bright, yellow, or rather orange-yellow coloured powder fell to the bottom. If, after the chlorine no longer appears to cause any change, the fluid is filtered, a colourless solution, with the strong odor of hypochlorous acid, is obtained, from which, with hydrate of potash in excess, a precipitate is deposited, which collected on a filter, is white, or approaching violet. This precipitate begins soon, however, to grow yellow in contact with the air. If the precipitate be again mixed with water and chlorine introduced, the greater part is dissolved, while a new portion of the yellow-coloured oxide is formed, and remains undissolved. The filtered solution forms a precipitate again with caustic potash, which is treated as before with chlorine, and this is repeated five or six times, when, finally, hydrate of potash precipitates from the solution an oxide which does not become in the least yellow by exposure to the air, and which suspended in water, is completely dissolved by the introduction of chlorine without leaving a trace of undissolved yellow oxide. It was to this oxide, not capable of being more oxidized either by the air or chlorine, that I gave the name of oxide of Lanthanium, after the production of which, and a nearer acquaintance with its properties, another and simpler method was employed to obtain it. The strong basic qualities of the new oxide afforded an easy means of separating it from oxide of cerium, by treating the red-brown oxide which is obtained when the so-called nitrate of protoxide of cerium is heated with nitric acid diluted with 75 to 100 parts of water. An acid thus diluted leaves the greater part of the red-brown oxide undissolved, and from the solution thus obtained the oxide of lanthanium was derived which was employed by me in the experiments that

I made in the beginning of the year 1839. Some of the results which I obtained unfortunately became known to the public. When we find the oxide of a body hitherto unknown, nothing, generally speaking, is easier than the determination of the qualities of the body, and I therefore expected to be able to give a complete account of my experiments in a very short time, but on this point I was much deceived. That which, in the first place, gives any value to chemical investigation, is the certainty that the object investigated is pure, that is to say, free from foreign substances. I had not made much progress in the details of my inquiry, when it appeared that what I at first had considered to be pure oxide of lanthanium, was, in point of fact, a mixture of the new oxide with a number of other substances, so that in the course of the experiments I succeeded in separating no less than seven different substances, one after the other. The first, to my great surprise, was lime, in no considerable quantity; and I have found that sulphate of lime and sulphate of potash forms a double salt sparingly soluble. Afterwards the following oxides were successively separated, and by the application of different means, namely, oxide of iron in large quantities, of copper, tin, nickel, cerium, and something resembling uranium, &c., but even the oxide which remained after the separation of all these substances, left me in nearly the same position which I held at the commencement of the researches, so that, although at the end of the year 1839 I had already been fortunate enough to obtain oxide of lanthanium tolerably pure, it was not until the beginning of the following year that I was able, with any facility, to obtain a larger quantity of it; but, notwithstanding all my efforts, I have not yet succeeded in discovering any method of separating, with any degree of analytical accuracy, lanthanium from cerium, &c.

Oxide of lanthanium, as pure as I have hitherto been able to obtain it, possesses the following properties:—It is of a light salmon colour, or nearly white, but not in the least reddish or brown, and retains its appearance unchanged when heated either in open or close vessels at a red or white heat: the slight colour seems to proceed from a small remnant of some foreign substance. The oxide, although just previously ignited to a white heat, soon changes its appearance in water, becomes snow-white, more bulky, and after twenty-four hours in the ordinary temperature of the air, becomes changed to a hydrate easily suspended in water. With boiling water this change takes place very quickly, and begins immediately; the newly heated oxide as well as the hydrate immediately restores the blue colour to moist reddened litmus paper. Oxide of lanthanium is easily dissolved by acids even much diluted. Salts, when they are formed by the combination of the oxide of lanthanium with uncoloured acids, are absolutely colourless, as well as the most concentrated solutions of the same. Salts of lanthanium have a sweet, slightly astringent taste, and the solution of them can be completely separated from oxide of lanthanium by the addition of sulphate of potash in sufficient quantity, because the double salt formed by sulphate of oxide of

lanthanium and sulphate of potash is quite insoluble in a solution saturated with sulphate of potash. The atomic weight of oxide of lanthanium, as it has hitherto appeared in most instances, has oscillated about 680, a number which, however, possesses no scientific value, when, as I have already remarked, an absolutely pure oxide has not yet been obtained.

Didymium

THE OXIDE of lanthanium which was first obtained by me was of a brown colour, but after having been heated to a white heat, became a dirty white; by heating in hydrogen it also lost its brown colour, although a scarcely perceptible loss of weight arose therefrom: by heating in the air, the brown colour returned.

This circumstance, together with several other phenomena which presented themselves during the examination of the properties of oxide of lanthanium, caused me to presume that the oxide of lanthanium which had been obtained was still accompanied by some unknown oxides, and it was in the beginning of 1840 that I succeeded in freeing lanthanium from that very substance which caused the brown colour. To the radical of this new oxide, I gave the name of Didymium (from the Greek word διδυμος whose plural διδυμοι signifies twins), because it was discovered in conjunction with oxide of lanthanium. It is the oxide of didymium that gives to the salts of lanthanium and cerium the amethyst colour which is attributed to these salts; also the brown colour which the oxides of the same metals assume when heated to a red heat in contact with the air. Notwithstanding all possible care, I have not yet succeeded in obtaining the oxide in a state of purity; and I have only arrived so far as to ascertain that a constant compound with sulphuric acid can be produced by different means, but from the quantity of water of crystallization, and other circumstances, the conclusion may be drawn that the salt is really a double salt, although I cannot at present say whether the other accompanying oxide is oxide of lanthanium, or some other.

I must not omit to mention on this occasion, that amongst the many other bodies which in the course of these researches I was obliged to examine, yttria also presented itself, and I have found that this earth, free from foreign substances, is perfectly colourless, and gives perfectly colourless salts: that the amethyst colour which the salts generally present comes from didymium, I will not, however, maintain.

Addendum, July 1843.

On Yttria, Terbium

I PUBLISHED last summer a short notice of Yttria, concerning which earth the following facts subsequently discovered merit attention. When I stated on the former occasion that pure yttria, as well as the salts of that base with a colourless acid, are colourless, my experiments had only gone so far

as to show that all the yttria which I could procure for examination might with ease be separated into two portions, the one a stronger and colourless base, the other a weaker, which, in proportion as it was free from yttria, acquired a more intense yellow colour on being submitted to heat, and with acids gave salts of a reddish colour. I continued my examination during the following autumn and winter, and thereby was not only enabled to confirm the correctness of my former observations, but made the unexpected discovery that, as was the case with oxide of cerium, what chemists have hitherto considered as yttria, does not consist of one oxide only, but is for the most part to be regarded as a mixture of at least three, of which two appear to be new and hitherto unknown, all possessing the greater number of their chemical characters in common, for which reason chemists have so readily overlooked their real differences.

The characters which are peculiar to these oxides, and distinguish them from all others are,—1st that although powerful salt bases, all more so than glucina, they are insoluble in water and in caustic alkalies, but on the other hand soluble, even after having been exposed to a strong heat, in a boiling solution of carbonate of soda, although after a few days the greater part separates from its solution in the form of a double salt; 2ndly, that combined with carbonic acid, they are largely soluble in a cold solution of carbonate of ammonia, and that when such solution is saturated with them, a double salt of carbonate of ammonia and the above carbonates immediately begins to separate, and that in such quantity, that after a few hours very little oxide remains in solution; which explains the observations of several chemists, that, as they express themselves, yttria sometimes dissolves freely, sometimes scarcely at all, in carbonate of ammonia: further, that the salts of these oxides have a sweet taste, and that the sulphates dissolve with more difficulty in warm than in cold water, without its following that they form double salts with sulphate of potash, which are insoluble in a saturated solution of the latter.

If the name of yttria be reserved for the strongest of these bases, and the next in order receives the name of oxide of terbium, while the weakest be called oxide of erbium, we find the following characteristic differences distinguishing the three substances:—The nitrate of yttria is extremely deliquescent, so much so that if a small portion of a solution of that salt be left for weeks in a warm place, the salt produced will not be free from humidity. The solution of nitrate of oxide of terbium, which is of a pale reddish colour, soon evaporates, leaving a radiated crystalline mass, which does not change in air unless it be very damp. The crystals of sulphate of yttria are colourless, and remain clear and transparent for weeks in air at a temperature varying from 86° Fahr. to 158° Fahr., while a solution of sulphate of oxide of terbium yields by evaporation, at a low temperature, a salt which immediately effloresces to a white powder. Oxide of terbium, the salts of which are of a reddish colour, appears, when pure, to be devoid of colour, like yttria. Oxide of erbium

differs from the two former in its property of becoming of a dark orange yellow colour when heated in contact with air, which colour it is again deprived of, with a trifling loss of weight, by heating it in hydrogen gas; and it is to the presence of oxide of erbium that yttria owes its yellow colour, when prepared as hitherto directed: and it is moreover probable, that in all those cases where a colourless yttria has been supposed to have been obtained, the presumed yttria has consisted for the most part of glucina, at least before it was known how to separate the last earth completely.

The sulphate and nitrate of the oxide of erbium are devoid of colour, although the solution of the oxide in acids is sometimes yellow, and the sulphate does not effloresce.

These and a number of other less remarkable differences between the three oxides, appear to me to place beyond a doubt that what we have hitherto obtained and described as yttria, is neither more nor less than a mixture of these three bases, at least such is the case with yttria prepared from gadolinite, cerine, cerite, and orthite, but as I have not yet had the good fortune to discover any tolerably easy or certain mode of obtaining the one or the other oxide chemically pure, I shall confine myself for the present to this short statement of facts . . .

That much time and labour have been employed in arriving even at the results which I have hitherto obtained, will be evident from the little I have been enabled to make known, particularly when it is considered that one or two grains of yttria have often been divided into nearly a hundred precipitates, which have been individually examined; but I live in hopes that the knowledge already obtained will soon enable me to publish a more complete account of my investigations.

Who's Who in This Month's Classic

CARL GUSTAVE MOSANDER (1797-1858 was professor of chemistry and mineralogy at the Caroline Institute, Stockholm. He took over the task of determining why the two recently discovered elements, yttrium and cerium, behaved peculiarly, and succeeded in splitting each of them in two. This was but the beginning of a long series of separations in establishing the anomalous group of rare earths.

New Rare Earth Series

THESE PUZZLING rare earth elements have recently taken on new interest for chemists through the announcement by nuclear fission researchers that the heaviest elements, beginning with actinium, form a second rare earth series.

Actinium corresponds with lanthanum, first element of the first rare earth series, which was separated from cerium by Mosander. Scandium and the element which finally kept the name yttrium are lighter analogues

with similar properties, but not truly members of the rare earth family.

Thorium in the second series corresponds with cerium in the first. No. 91, the rare protoactinium, is the chemical partner of praseodymium, one of the "twin" elements into which Mosander's didymium was resolved. Neodymium, the other "twin" finds its match in uranium, the fission element.

Neptunium first of the man-made elements which extend the list, finds its counterpart in No. 61. The name "illinium", formerly given to the element filling this place, has been withdrawn because, in the nuclear fission researches, data has been obtained showing that the properties of the element which must fill that place are different from those ascribed to "illinium". This is but the latest of many such revisions of the rare earths.

Samarium, an element found in the didymium fraction after Mosander's time, corresponds, in the earlier series, with plutonium, of atomic bomb fame in the later.

Americium, No. 95, was named for America in order to correspond to Europium, and Curium, No. 96, was given its name to honor Marie and Pierre Curie because Gadolinium was named in honor of another chemist, discoverer of the first of the rare earth elements.

Since there remain seven members of the original rare earth series, the obvious next question is, will there be as many more new elements added as the result of nuclear researches? According to theory, there should be. Although naturally reluctant to prophesy too boldly, atomic researchers say that the total number of elements will probably at least reach one hundred.

Fluxing Fuel Cuts Concrete

➤ No longer need a neighborhood be disturbed by the deafening noises of the air compressor cutting away pieces of concrete in street or sidewalk. A flux-forming fuel, and method of use, patented recently, permits a noiseless process. While it is particularly applicable in piercing round deep blasting holes in concrete and hard iron ore, it can be used to make grooves or cuts in the mineral materials.

The flux is a mixture of free-flowing finely pulverized materials, fed continuously into the blowpipe flame of an oxygen burner. It is composed of varying quantities of iron, manganese, silicon, aluminum, and either zirconium or calcium. A convenient way to get the mixture is to use ferromanganese, zirconium-silicon alloy, and aluminum, all in finely divided form. Calcium-silicon alloy can replace the zirconium alloy in whole or in part.

This mixture, when burned in gaseous oxygen, provides much heat. It forms oxides with the materials being cut, and these are in the form of a highly fluid slag. The gaseous products of combustion force the slag from the hole.

Patent 2,402,947 was granted Charles J. Burch, Plainfield, N. J., for this invention. It has been assigned to the Linde Air Products Company.

Radio Club of Middle West Joins World-Wide Group of Science Clubs

Teen-Age Science Club No. 10,000

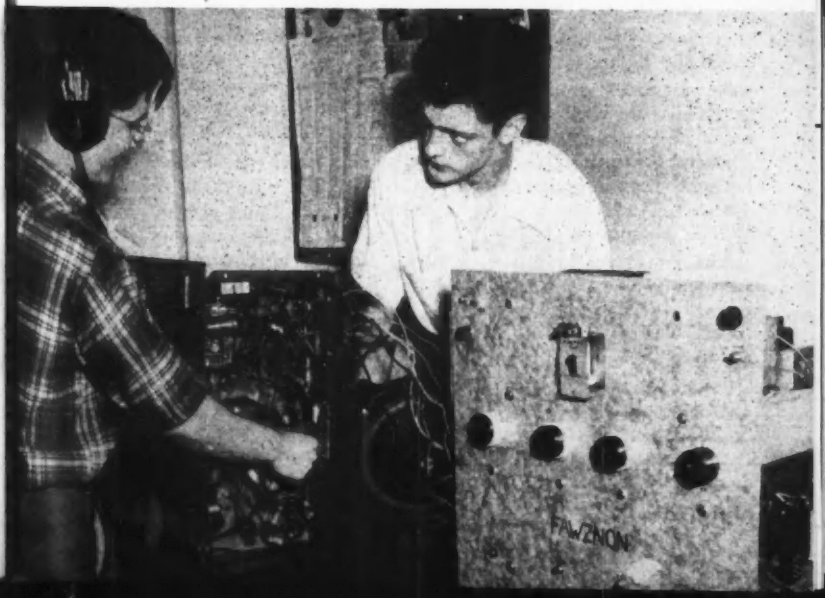
➤ THE HONOR of being club number 10,000 affiliated with Science Clubs of America falls to a radio club in the Middle West. It is typical of the teen-age groups that make up this international science organization, the largest in the world.

Club 10,000 has been organized nine years and has 19 members. It is the Bloom Radio Club of Chicago Heights High School, Chicago, Ill.

During its lifetime, 15 boys and one girl have become licensed amateur operators. At least 75 others have been or are now doing some phase of radio or radar work in the armed services.

Service to the school is a keynote

➤ TWO BOYS *named Bill are demonstrating radio equipment they have made as one of the projects carried out by Science Club No. 10,000. Physics, chemistry, biology and many other sciences furnish fields in which teen-agers in Science Clubs utilize their energy and enthusiasm in research programs that are fun to do. Bill Woodhull of the Bloom Radio Club is explaining to Bill Whitney the function of a resistor in the complicated circuit of the ten-tube superhetrodyne he has built.*



of the club. Members installed bells, an electric clock and telephone in the school's agriculture building. The club operates the school's portable public address systems, maintains the movie projectors and other visual education equipment, and cares for the school's transcription players.

The first project of the club was to build and install the centralized sound system that gives the principal instantaneous contact with all 66 classrooms. Working on Saturdays, evenings and holidays, members of the club strung out seven miles of wire and connected 84 loud speakers in this project alone.

One member operates the sound system carrying school announcements and lunch-time music; another, the portable transcription player. Four members make sure the portable amplifier is in top condition for dances, social hours and banquets; in the fall the same unit is employed to carry play-by-play accounts of home football games.

In return for such liberal services, the school furnishes the club with a room and workshop. Here members in their spare time work with the maze of receivers, transmitters, test equipment and other electronic gear. Licensed members constructed and operate the group's own radio station, W9HFN (radio call W9YB).

The club meets twice a week after school when members are instructed in radio theory. Anything from a crystal detector to a superhetrodyne is discussed, diagramed and explained.

Every noon-time is code-time in the clubroom where members practice under the experienced eye of a license-holder. Each tries to reach the goal of a minimum receiving speed of 13 words per minute necessary for a Class B amateur license.

Like all science clubs, each member has a project—in most cases working with his own radio parts. Those who cannot afford to buy their own are loaned one of the club's nine complete kits.

From experimenting with radio parts, the boys soon learn how to repair radios for their families and friends. This free radio repair service is also extended to the teachers.

Members keep the club solvent by selling candy and ice-cream and running various concessions around the school.

Biggest morale booster to the group was the return of their sponsor, James F. Sears, just back from the Pacific where he was captain in the Marine Corps Reserve. Next year they will have to keep in touch with him by radio as he is going on to college teaching.

Science Clubs of America includes about 250,000 members as energetic and alert as those of club number 10,000. Sponsored by Science Service, clubs specializing in any kind of science activity can join free of charge.

➤ Science Clubs of America *supplies free manuals to affiliated clubs describing science activities that have proved popular and practical. Write to Science Clubs of America, 1719 N St. N.W., Washington 6, D. C. for further information.*

➤ AT THE SCIENCE FAIR *in Providence, R.I. boys and girls crowded around the Science Clubs of America exhibit to learn what other clubs are doing, how their schools can take part in Science Club activities. Is there a Science Club in your school?*

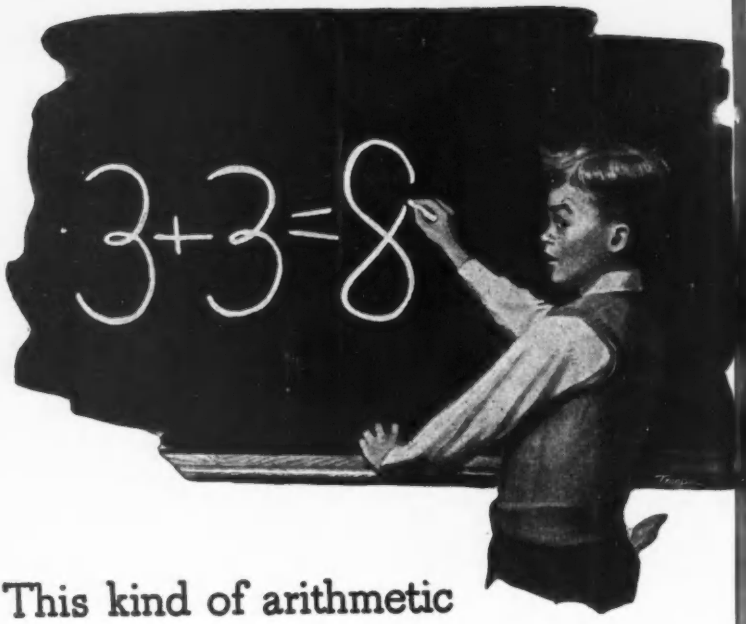
Here's Your Invitation

Is there a science club in your school? If there isn't, why not form one today?

Then affiliate your club with Science Clubs of America. There is no charge for this privilege. Your club can thus share the experiences and opportunities enjoyed by the quarter of a million boys and girls now belonging to Science Clubs of America.

Science clubs are proving grounds for the discovery and development of scientific talents and skills for careers and hobbies in science. Science moves ahead with such rapid strides there isn't time enough in the school curriculum to provide for those students who are especially interested in science. The science club is the opportunity for talented students to display their ingenuity and versatility in science.

Science clubs may be general or specific. Many choose chemistry.



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